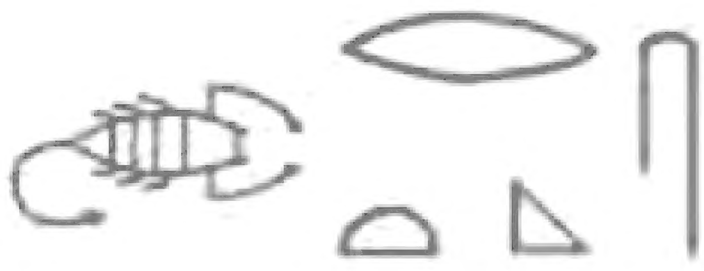

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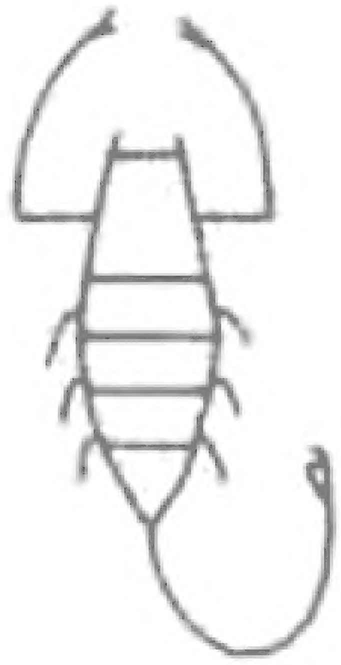

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The remarkable micro-scorpion genus *Microbuthus* Kraepelin, 1898 in North Africa; description of a new species with comments on its biogeography and ecology (Scorpiones: Buthidae)

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Abstract

A new species, *Microbuthus saharicus* sp. n., is described from the inland deserts of Mauritania; it represents the first exception to the general coastal distribution observed in the species of this genus. With this new description, the total number of known species in Africa is increased to five. The disrupted peri-Saharan pattern of distribution presented by the group is however confirmed. Some comments are also added on the biogeography and ecology of the species.

Keywords: Scorpion, *Microbuthus*, Buthidae, new species, Mauritania.

Introduction

As previously summarized in earlier publications (Vachon, 1952; Lourenço, 2002, 2011; Lourenço & Duhem, 2007) the genus *Microbuthus* was originally described by Kraepelin (1898), with the type species being *Microbuthus pusillus* Kraepelin, 1898 which was collected from the region of Tadjura Bay (= Tadscharabay) in the Gulf of Aden (= Yemen). Subsequently, a second species *Butheolus litoralis* Pavesi, 1885 from Assab, on the Red Sea coast of Eritrea was transferred to the genus *Microbuthus* by Birula (1905). The genus *Microbuthus* was represented exclusively by these two species until the description of *Microbuthus fagei* by Vachon (1949) based on specimens collected at Nouakchott in the coastal region of the Atlantic Ocean in the South of Mauritania. More recently, Lourenço (2002) studied a larger sample of specimens from

both Mauritania and Morocco and proposed the description of a subspecies for *Microbuthus fagei* for the region of Tan-Tan in South Morocco as *Microbuthus fagei maroccanus* Lourenço, 2002. Subsequently, *Microbuthus maroccanus* was raised to the rank of species (Lourenço & Duhem, 2007).

The unexpected discovery of a quite particular specimen of *Microbuthus* in Egypt led to the description of a new species, *Microbuthus flavorufus* Lourenço & Duhem, 2007 (Fig. 1). This marked the first record of the genus *Microbuthus* for the country. In the subsequent years, there were no new contributions to the African *Microbuthus*. However, studies conducted in the Middle East, resulted in the description of new species, namely *Microbuthus gardneri* Lowe, 2010, *Microbuthus kristensenorum* Lowe, 2010 and *Microbuthus satyrus* Lowe, Kovařík, Stockmann & Stahlavsky, 2018 from Oman and Yemen (Lowe, 2010; Lowe *et al.*, 2018). Some difficulties for the study of the species of the genus arise from the fact that most species are rare, and some original types have been mislaid. This was the case for the type of *Butheolus litoralis* (= *Microbuthus litoralis*) which could not be found in any Italian Museum, what led to the proposition of a neotype for this species (Lourenço, 2011). In this same occasion the synonym of *Microbuthus pusillus* Kraepelin, 1898 with *Microbuthus litoralis* (Pavesi, 1885) was confirmed (Lourenço, 2011). While the type material of *Microbuthus fagei*, consisting of two specimens, remains misplaced in the collections of the Muséum in Paris, the characterisation of topotypes of this species allows for its accurate definition.

Among the wide array of known genera of Buthidae scorpions, *Microbuthus* remains enigmatic. The reasons for this are associated not only with the several unique morphological features of the different species, but are also due to the scarcity of available material for study. At present, a new species is described from the inland deserts of Mauritania, escaping therefore to the previous observed pattern of distribution along coastal zones. This discovery marks the fifth species documented in Africa. The disrupted peri-Saharan pattern of distribution observed among the species of the genus appears to be reaffirmed once more.

Fig. 1. Female holotype of *Microbuthus flavorufus* alive in the natural habitat in Egypt.

Material and Methods

Illustrations and measurements were produced using a Wild M5 stereo-microscope with a drawing tube and an ocular micrometre. Measurements follow Stahnke (1970) and are given in mm. Trichobothrial notations follow Vachon (1974), morphological terminology mostly follows Vachon (1952) and Hjelle (1990), and chelicerae dentition follows Vachon (1963). The type material described in this paper will be deposited in the collections of the 'Museu Nacional', Rio de Janeiro, Brazil.

The recognized species of *Microbuthus* Kraepelin, 1898 (African species in bold)

M. litoralis (Pavesi, 1885)
M. fagei Vachon, 1949
M. maroccanus Lourenço, 2002
M. flavorufus Lourenço & Duhem, 2007
M. gardneri Lowe, 2010
M. kristensenorum Lowe, 2010
M. satyrus Lowe, Kovařík, Stockmann & Stahlavsky, 2018
M. saharicus sp. nov.

Taxonomic treatment

Family **Buthidae** C.L. Koch, 1837
Genus ***Microbuthus*** Kraepelin, 1898
Microbuthus saharicus sp. n. (Figs. 2-10)

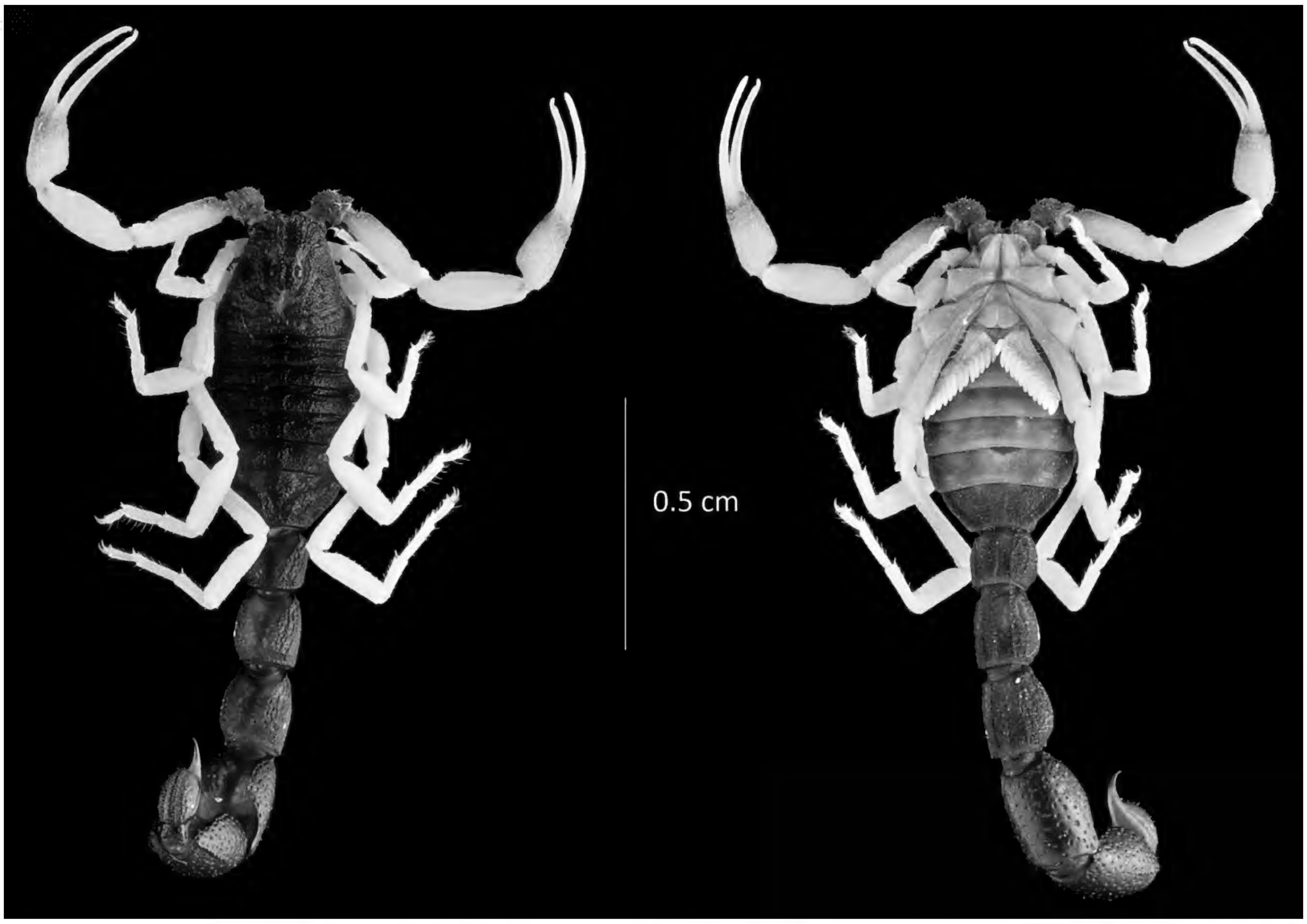
Type material: Male holotype, Mauritania, Bivouac de Tinterkat (near to Wadane), 20°56'39.45" N, 11°33'36.69" W; 4/XI/2001 (P. Lluch). The holotype will be deposited in the Museu Nacional, Rio de Janeiro, RJ, Brazil, as a contribution to the reposition of the collections destroyed by fire in 2018.

Etymology: Specific name refers to the Sahara Desert where the new species was found.

Diagnosis. A rather small species of scorpion; the total length reaches only 17.80 mm. Colouration dark as in some other species of the genus; the body is globally dark while the appendages are almost entirely yellow. Pectinal tooth count 12-13. Metasomal segment I wider than long; segments II to V longer than wide. Tibial spurs on leg III reduced; well developed on leg IV. Trichobothrial pattern: minorante neobothriotaxy; chela (hand + fixed finger) with the absence of trichobothria **est**, **Esb**, $\mathbf{Eb_3}$; patella with trichobothria $\mathbf{d_1}$ absent and $\mathbf{d_3}$ in a proximal position; seven external trichobothria, but with trichobothrium **em** strongly reduced; femur with the absence of trichobothria $\mathbf{d_2}$, and a reduced $\mathbf{d_5}$. Tibial spurs moderate on leg III and well developed on leg IV.

Relationships: By its general morphology the new species shows some affinities to both *Microbuthus maroccanus* from Morocco and *Microbuthus fagei* from Mauritania. However, the new species can be readily distinguished by its overall darker pigmentation on the tergites and sternites and a distinct number of trichobothria equally disposed in distinct positions.

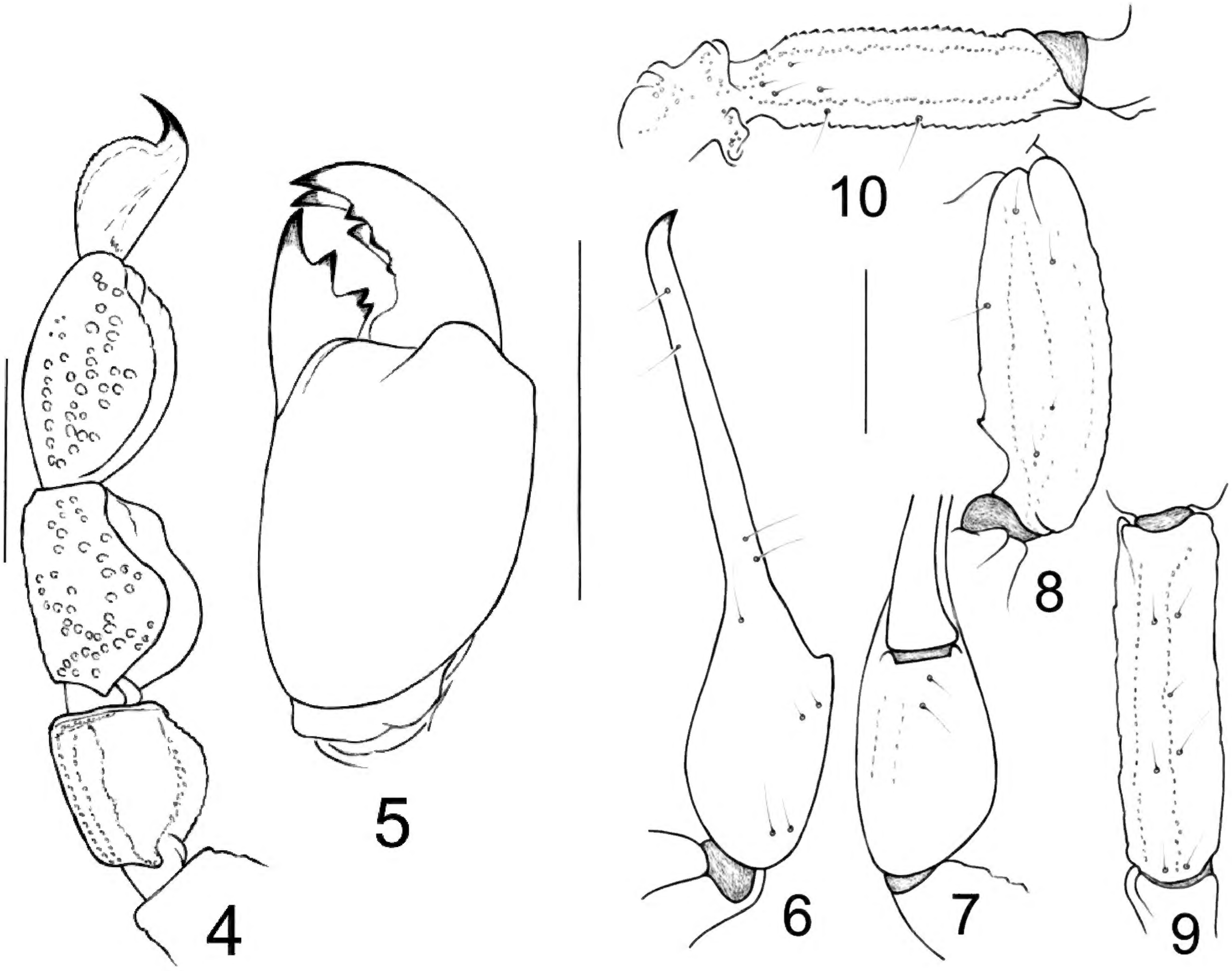
Description based on male holotype (measurements following the description).



Figs. 2-3. *Microbuthus saharicus* sp. n. Male holotype. Habitus, dorsal and ventral aspects.

Colouration (Figs. 2-3). Body dark brown with appendages yellow to pale yellow; only coxa and trochanter of pedipalps are dark. Prosoma: carapace dark brown; eyes intensely marked with a black pigmentation. Mesosomal tergites dark brown; tergite VII slightly paler with some yellowish zones. Metasomal segments I to V brown to dark brown with some yellowish zones; segments IV and V darker than I to III. Vesicle reddish-yellow; aculeus yellowish at the base and reddish at the tip. Venter, coxapophysis, sternum, genital operculum and pectines yellowish; pectines paler than the other structures; sternites yellowish with marked brownish zones; sternite VII darker than the others. Chelicerae yellow with some dark reticulated spots at the base of fingers; fingers yellowish with reddish teeth. Pedipalps pale yellow with coxa and trochanter dark brown, including proximal zone of femur; granulations on cutting edge of fingers slightly reddish. Legs pale yellow without any spots.

Morphology. Carapace strongly narrowed anteriorly, almost triangular; anterior margin with a vestigial median concavity; almost straight. Carinae weakly marked; granulations moderately to strongly marked by pearl-like granules. Furrows weak. Median ocular tubercle only slightly anterior to the centre of the carapace; median eyes separated by one and half ocular diameters. Three pairs of lateral eyes; the third pair reduced. Sternum triangular, longer than wide. Mesosomal tergites moderately to strongly granular. Median carina moderate and present in all tergites; the two lateral carinae vestigial. Tergite VII pentacarinate, moderately crenulate. Venter: genital operculum of moderate to large size divided longitudinally and wider than the sternum. Pectines: pectinal tooth count 12-13; basal middle lamellae of the pectines not dilated; fulcra moderate. Sternites III-VI with thin granulations; granules on VII stronger with four vestigial carinae; two lateral furrows present on sternites III-VI. Short slit-like spiracles. Metasoma: segments rounded with ten



Figs. 4-10. *Microbuthus saharicus* sp. n. Male holotype. 4. Metasomal segments III-V and telson, lateral aspect. 5. Chelicera, dorsal aspect. 6-10. Trichobothrial pattern. 6-7. Chela dorso-external and ventral aspects. 8-9. Patella, dorsal and external aspects. 10. Femur, dorsal aspect. (Scale bars: 4: 2 mm, 5: 0.5 mm, 6-10: 1 mm).

carinae moderately marked on segments I to III; carinae on segment III partially fused with the granulations; segments IV and V with only vestigial dorsal carinae and with numerous punctuations. Intercarinal spaces moderately granular. Telson slightly punctuated, with two small lateral furrows and one ventral carina with a serrula shape; aculeus very short and strongly curved; subaculear tooth absent. Cheliceral dentition characteristic of the family Buthidae (Fig. 5): the basal teeth in the movable finger are almost fused (Vachon, 1963). Pedipalps: femur pentacarinate; patella with seven weak carinae and the internal face without any spinoid granule; chela with vestigial carinae; all faces with thin but intense granulation. Fixed and movable fingers with one linear row of granules divided by some stronger accessory granules; extremity of the fingers with one strong accessory granule giving the shape of forceps to the fingers. Trichobothriotaxy (Figs. 6-10): minorante neobothriotaxy; A-β (beta) for the disposition of the dorsal trichobothria of the femur (Vachon, 1974, 1975); chela (hand + fixed finger) with the absence of trichobothria **est**, **Esb**, $\mathbf{Eb_3}$; patella with trichobothria $\mathbf{d_1}$ absent and $\mathbf{d_3}$ in a proximal position; seven external trichobothria, but with trichobothrium **em** strongly reduced; femur with the absence of trichobothria $\mathbf{d_2}$, and a reduced $\mathbf{d_5}$. Legs: tarsus with a few median fine setae ventrally; pedal spurs moderate on legs III and IV; tibial spurs moderate on leg III and well developed on leg IV.

Morphometric values (in mm) of the new species. Total length, 17.80*. Carapace: length, 2.41; anterior width, 1.54; posterior width, 2.87. Mesosoma length, 3.94. Metasomal segments (Fig. 4). I: length, 1.34; width, 1.47; II: length, 1.62; width, 1.34; III: length, 1.74; width, 1.62; IV: length, 2.21; width, 1.74; V: length, 2.47; width, 1.87; depth, 1.54. Telson length 2.07; vesicle: width, 0.87; depth, 0.84. Pedipalp: femur length, 2.21, width, 0.67; patella length, 2.27, width, 0.87; chela length, 4.21, width, 0.87, depth, 0.81; movable finger length, 2.54 (* including telson).

Biogeography of the genus *Microbuthus*

The description of the new species, although collected in more inland deserts of Mauritania, suggests a potential disrupted peri-Saharan distribution pattern for African *Microbuthus* species (Fig. 11). This pattern was initially proposed by Vachon (1952) and subsequently re-affirmed by Lourenço (2002, 2011) and Lourenço & Duhem (2007). However, it was rejected by Lowe (2010) and Lowe *et al.* (2018) who stated as follows: *'The apparent widely disjunct distribution of Microbuthus in eastern and western coastal locations of North Africa was proposed to reflect a fragmentation or regression of ancient mesic faunas that were unable to adapt to xeric conditions that accompanied advent of the Sahara Desert'.* In addition, they also stated *'The fact that the few available museum specimens of Microbuthus were collected near coastal areas may reflect a bias in the sampling of small cryptic faunas for more densely populated and easily traveled coastal routes.'*

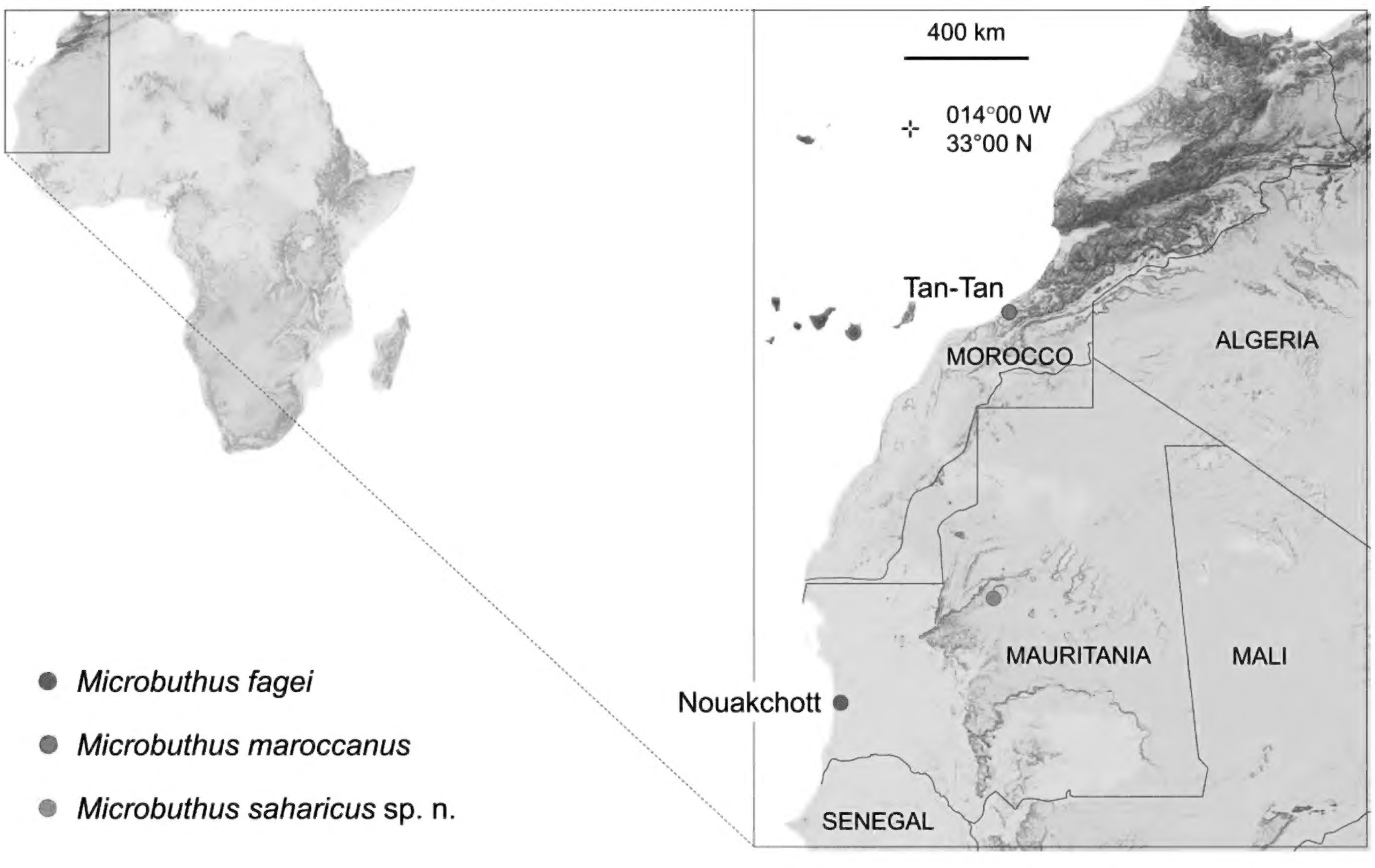


Fig. 11. Map of Occidental North Africa with the type localities of *Microbuthus* species known from this area.

These statements involve some degree of speculation. In fact, intense collecting predominantly occurred in what was formerly the 'Afrique Occidentale Française' field trips have been conducted not only over coastal areas, but very often in the inland regions (see Lourenço, 2019). Besides, *Microbuthus* is not the only genus presenting a particular pattern of distribution. Another example is the distribution pattern of the genus

Butheoloides Hirst, 1925. This genus is globally absent from the Central compartment of the Sahara Desert with all its species distributed in more mesic environments surrounding the Desert areas (see Lourenço, 2013). Consequently, the earlier hypothesis (Lourenço, 2002; Lourenço & Duhem, 2007) may still hold until new evidence emerges from the central portion of North Africa. I summarize here again some aspects of what was suggested before.

Furon (1951) suggested that the flora and fauna now present in the Sahara region may have ancient origins. Their present pattern is not solely the consequence of palaeogeographic factors, but is also significantly shaped by various palaeoclimatic events. These palaeoclimatic events had an important impact during the Quaternary period when Europe (and North America) underwent glaciation cycles. Meanwhile, Africa experienced periods of heightened rainfall and a notable increase in ice accumulation on its mountains, particularly in Eastern Africa. The most recent wet period in the Sahara occurred very recent, only some 5,000 years BP.

Qi & Lourenço (2007) emphasized that the current composition of the Saharan fauna likely represents the legacy of ancient faunas that have been present in North Africa since the early Cenozoic, or at least since mid-Cenozoic times (Vachon, 1952). North Africa has experienced numerous other palaeoclimatological vicissitudes in the last few million years, some of which occurred in more recent Quaternary times. The Sahara has undergone a long series of wet periods, the most recent occurring 10.000-5000 years BP. It was not until approximately 3000 years BP that the Sahara assumed its present arid state (Cloudsley-Thompson, 1971, 1974, 1984). Recent studies suggest that the Sahara Desert may be much older than was previously thought (Schuster *et al.*, 2006). It seems reasonable, therefore, to postulate that extremely arid areas may have existed as patchy desert enclaves for a very long time, even when the overall climate in North Africa enjoyed more mesic conditions. Within these desert regions, a specialized scorpion fauna would have evolved. In contrast, other lineages less well adapted to drought, and previously present only in mesic environments, have regressed markedly in their distribution. They have therefore experienced negative selection and are on the road to extinction. In other cases, populations have been reduced to very limited and patchy zones sometimes with remarkable disjunctions in their distribution patterns.

Among the patterns observed today in the distribution of North African scorpions (Qi & Lourenço, 2007) one of the most intriguing is the disjunction presented by the distribution of the genus *Microbuthus*, with two species known in Mauritania and Morocco in the West and two others respectively in Egypt, Eritrea and Djibouti in the East (and three more species in the Middle East). Vachon (1951a, 1952) had already drawn attention to this extremely localized pattern of distribution of the species of *Microbuthus* and defined it as a 'disrupted and limited territory'. Vachon also attempted to explain the observed pattern and made reference to Braestrup (1947) who had suggested a mechanism for exchanges through the Sahara Desert. According to this mechanism, Southern elements (Ethiopian) were able to reach the Northern regions, and Northern elements (Palaearctic) were able to disperse to the Southern regions of the Sahara. However, this hypothesis primarily applies to dynamic elements with a strong dispersal capacity. Scorpion populations, in contrast, are often stable and less adaptable to new environments. The present distribution patterns of several scorpion groups, particularly the one presented by the genus *Microbuthus*, likely reflect a broader range of distribution in the past. The distinct palaeoclimatic vicissitudes experienced by the Sahara have constituted an important selective factor over its scorpion populations. The reaction of these to abiotic factors was certainly varied depending on their own ecological strategies (Polis, 1990; Lourenço, 1991). In some cases, the populations showed a

significant regression in their distribution, and some populations may well have totally vanished. These regressions led to marked disruptions in geographic distributions and resulted in their present patchy distribution. This hypothesis offers a potential explanation for the disrupted distribution pattern of *Microbuthus* species.

Ecological and biological comments

According to Vachon (1951b), *Microbuthus* species could be classified as halophiles, since up to that date these were exclusively found in coastal zones, stretching from the Red Sea to the Atlantic Ocean. This ecological particularity was further confirmed for other species such as *M. maroccanus* (see Lourenço, 2002 for details). Lowe (2010) however, rejected this ecological trait and argues that for the species found in the Middle East this characteristic was unreliable. The new species described here, seems to confirm in part this assumption (Fig. 12). It was collected far from coastal zones and on an arid environment. Further discoveries should bring a more precise ecological pattern.

Fig. 12. Typical desert formation in Central Mauritania, near to the type locality of *Microbuthus saharicus* sp. n.

The fluorescence observed in *Microbuthus* species appears to be variable. In fact, for some living specimens of *M. litoralis* it proved to be rather weak. Fluorescence was previously considered as a global trait in scorpions, but more and more exceptions are presently found (see Lourenço, 2012).

The reproductive biology of most micro-scorpions remains relatively unexplored, but preliminary observations have revealed certain peculiarities. For instance, limited observations on *M. fagei* demonstrated that broods are composed of very small numbers, ranging from 3 to 4 (Lourenço, 2002, 2007). In contrast, pro-juveniles at birth are very large at birth. Female body length averages 8.4 mm, while pro-juveniles body length

averages 4.2 mm. No precise data, however, are available on the embryonic and postembryonic development of the species. Nevertheless, using indirect methods and the morphometric values of juveniles collected in nature, it can be estimated that four moults are required to reach adulthood.

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***Microbuthus saharicus* Lourenço, 2023**
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Plexippus C.L. Koch, 1846: a new genus for the Moroccan araneofauna (Araneae: Salticidae)

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Abstract

This is the first record of genus *Plexippus* C.L. Koch, 1846 from Morocco through the records of two species: *Plexippus devorans* (O. Pickard-Cambridge, 1872) based on three male specimens collected from Tinghir (southeastern Morocco) and *Plexippus paykulli* (Audouin, 1825) based on three specimens (two males from Beni Mellal, and one single female from Fez).

Keywords: *Plexippus*, *Plexippus devorans*, *Plexippus paykulli*, Morocco.

Introduction

Morocco has an important biodiversity, and this includes spiders as well. Our knowledge about Moroccan araneofauna is very limited and needs more studies, as we indicated in a previous study (Mousaid & Bouihouline, 2023). The jumping spiders are diurnal animals, unlike most other spiders. And they largely live in urban areas in close proximity to humans. Morocco has only 24 different genera of jumping spiders (Nentwig *et al.*, 2023). Genus *Plexippus* C.L. Koch, 1846 is not one of them.

Plexippus devorans (O. Pickard-Cambridge, 1872) is one of the small species of the genus whose distribution, according to the World Spider Catalog (2023), includes Cyprus and Palestine/Israel. According to the original description of this species, it is characterized by the absence of the two dark bands on the cephalothorax, unlike *Plexippus paykulli* (Audouin, 1825) for example (Pickard-Cambridge, 1872). The status of this species and *Plexippus strandi* Spassky, 1939 (this species is very similar to *Plexippus devorans* even in palp morphology) is somewhat ambiguous. Prószyński

(2003) described some specimens from Palestine/Israel as *P. devorans*, but later in 2017 he refuted this and described it as a new species: *Plexippus gershomi* Prószyński, 2017 (Prószyński, 2017). Later, Logunov (2023) proposed the synonymy of *Plexippus strandi* with *Plexippus gershomi* and *Plexippus strandi dushanbinus* Andreeva, 1969, like Nenilin (1985) who proposed the synonymy of the species name with *Plexippus coccineus* Simon, 1902. The problem with *Plexippus devorans* is that the original specimens are lost; there is no holotype to refer to for a new description and a genetic test. It is possible that *Plexippus devorans* and *Plexippus strandi* are the same species. Overall, three male specimens were collected and examined from Morocco, and we identified them as *Plexippus devorans* with the help of a group of senior researchers.

Plexippus paykulli (Audouin, 1825) also known as a pantropical jumping spider, is a cosmopolitan species of African origin and introduced to Europe, the Americas, the Middle East, southern Asia, Australia, and the Pacific Islands (Pupin & Brescovit, 2023). This species is recorded in all North African countries except Morocco (Nentwig *et al.*, 2023). However, the distribution of the species in the country remains very likely. In this paper we also present the first record of *P. paykulli* from Morocco based on three specimens.

Material and Methods

Three male specimens of *Plexippus devorans* were collected from Douar Achtat, Tinghir region in July 2023. Also, two male specimens of *Plexippus paykulli* were collected from the courtyard of the Beni Mellal university complex in Mghila in June 2023 and a single female specimen of *P. paykulli* was collected from Faculty of Sciences and Technics Fez in October 2023 (Fig. 1). All specimens were preserved in 96% ethanol and microscopically examined in the Functional Ecology and Environmental Engineering laboratory in the Faculty of Sciences and Technics Fez, where the specimens were placed.

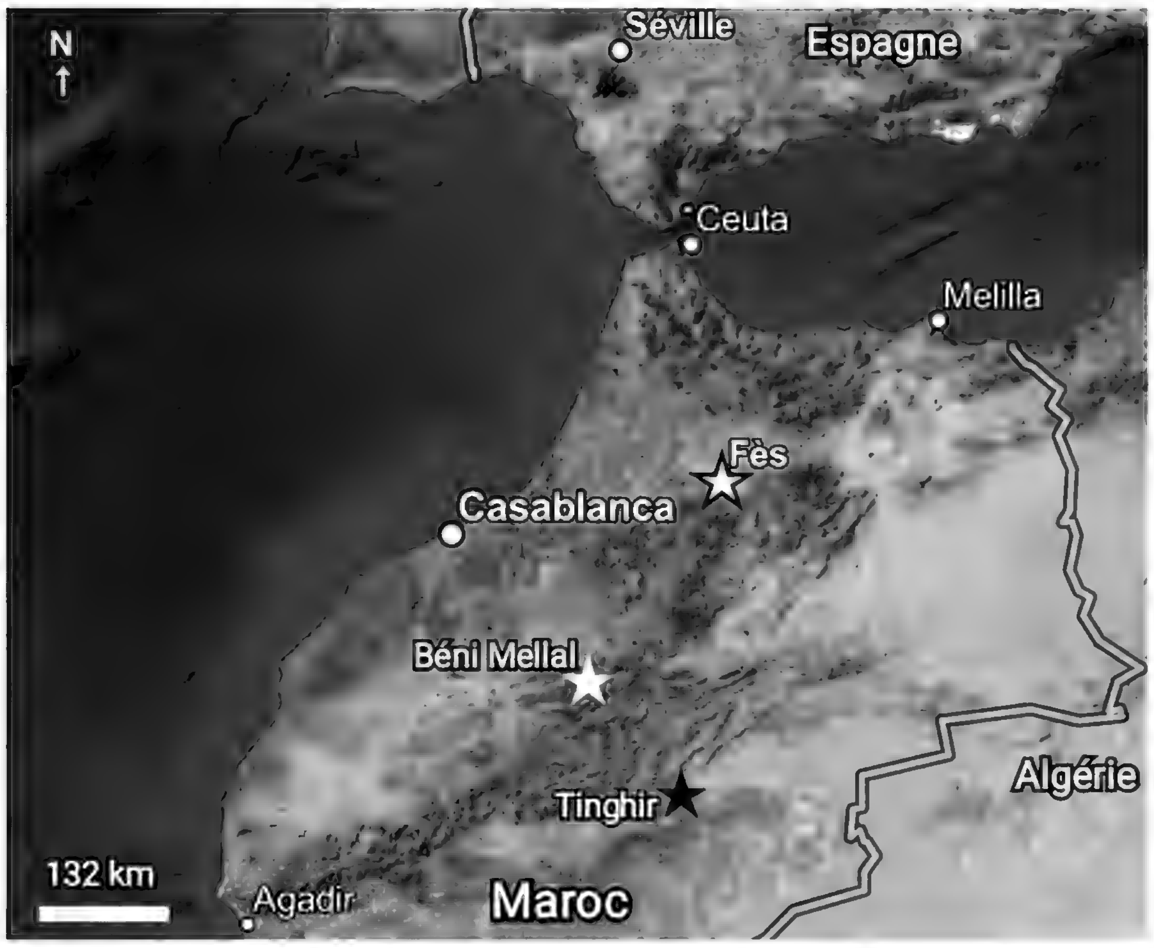


Fig. 1. Map of northern Morocco showing specimens collecting stations: *Plexippus paykulli*, 2♂♂ (white star), 1♀ (white banded star) and *Plexippus devorans*, 3♂♂ (black star).

Results

Plexippus devorans (O. Pickard-Cambridge, 1872) (Figs. 2-6)
Salticus devorans O. Pickard-Cambridge, 1872: 327 (D♀).
Hasarius devorans Simon, 1876a: 90.
For more synonyms, see the World Spider Catalog (2023).

Identification reference:
Prószyński (2003: 144, figs. 584-585).

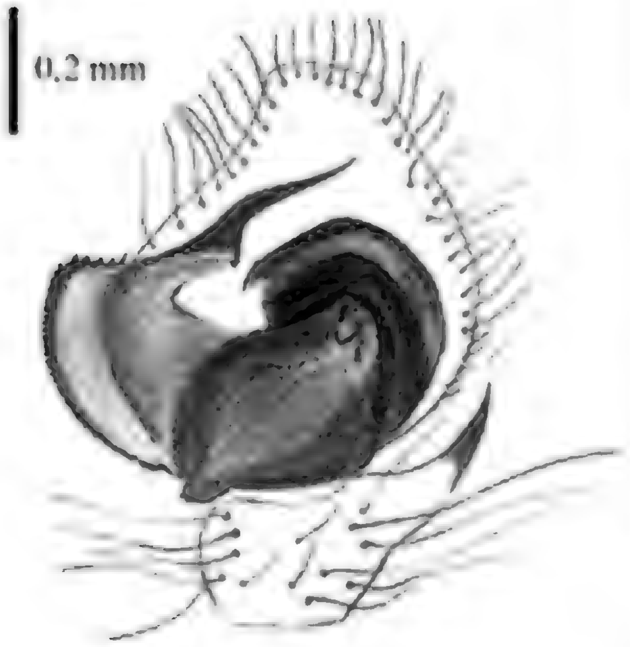
Material examined: 3♂♂, Douar Achtat, Tinghir region (31°26'33.7"N, 5°26'17.6"W), collected on 27/07/2023, examined on 02/11/2023.

Fig. 2. *Plexippus devorans* (O. Pickard-Cambridge, 1872) ♂, alive, from Ifrane Anti-Atlas, Morocco (© Abderahim Elaouad).

3 4

Figs. 3-4. *Plexippus devorans* (O. Pickard-Cambridge, 1872) ♂, habitus. 3. dorsal view. 4. ventral view.

Description of the male (Figs. 2-4)**:** Small spiders, 5.5 mm long, general colouration is yellowish white, with two dark bands on the sides of the opisthosoma. Four dark spots in the prosoma two of which are located in the position of the posterior eyes (Fig. 3). These males are similar to the larger males of *P. paykulli*, but it is easy to distinguish the two species based on the difference of size, as well as the obvious difference in the prosoma. Unlike *P. devorans*, *P. paykulli* prosoma is yellowish white with two dark bands on sides. Palpal organ: the sperm duct is large and prominent unlike what we see in *P. paykulli* palp (Figs. 5-6).



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Figs. 5-6. *Plexippus devorans* (O. Pickard-Cambridge, 1872), male palpal organ, ventral view.

Description of the habitat: These specimens were collected from Douar Achtat, Tinghir (Southeastern Morocco) (altitude: 1240 m) (Fig. 7). Generally this region is characterized by its arid climate and special vegetation interspersed with *Phoenix dactylifera* (the distinctive vegetation of the region), *Vachellia tortilis* subsp. *raddiana*, *Tamarix* sp., *Ziziphus lotus*, *Olea europaea* (planted).

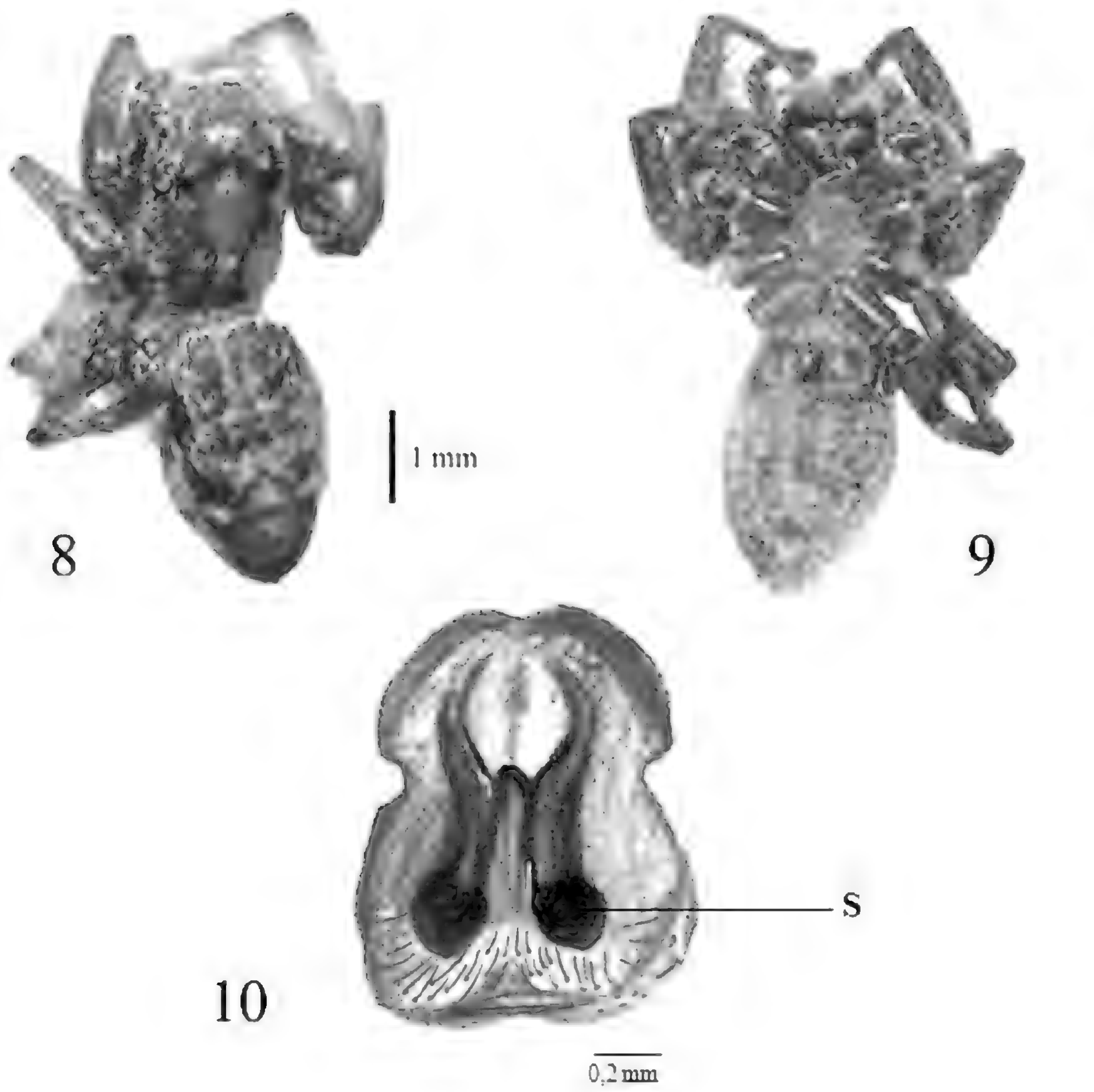
Fig. 7. Arid habitat in Tinghir, southeastern Morocco.

Plexippus paykulli (Audouin, 1825) (Figs. 8-15)
Attus paykullii Audouin, 1825: 409, pl. 7, f. 22 (D♂).
Attus ligo Walckenaer, 1837: 426, pl. 12, f. 4 (D♂).
Euophrys vetusta C.L. Koch, 1846: 219, f. 1264 (D♀).
Salticus vaillantii Lucas, 1846: 136, pl. 5, f. 2 (D♂).
Salticus culicivorus Doleschall, 1859: 14, pl. 9, f . 5 (D♀).
Attus africanus Vinson, 1863: 52, 301, pl. 10, f. 3 (D♀).
For more synonyms, see the World Spider Catalog (2023).

Identification references:
Metzner (1999: 255, fig. 101 a-b-c-d).
El-Hennawy *et al.* (2015: 132, figs. 8-11).
Pupin & Brescovit (2023: 3, figs. 1-6).

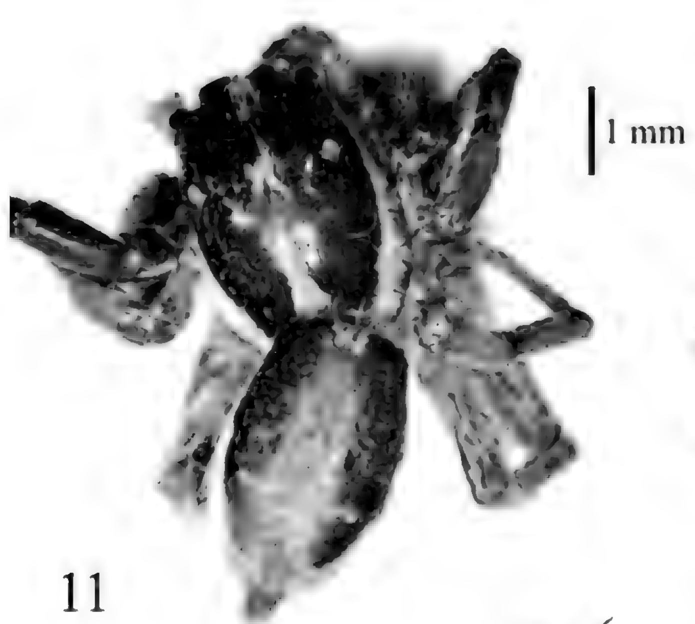
Material examined: 2♂♂, University complex (Sultan Moulay Slimane) in Mghila (32°22'16.4"N, 6°19'02.1"W) on 17/06/2023; 1♀, Faculty of Sciences and Technics Fez (33°59'58.2"N, 4°59'20.6"W) on 09/10/2023. Examined: 2♂♂, 17/06/2023, 1♀ 02/11/2023.

Description of the female (Figs. 8-9)**:** The specimen was approximately 7.5 mm long, the colouration is dark brown with a light band in the middle of both the prosoma and the opisthosoma with two light spots in the posterior third of the opisthosoma (Fig. 8). Epigynum: mainly covered by semitransparent brown waxy secretion (Figs. 10, 15) as Prószyński (2003) indicated in his description of the species.



Figs. 8-10. *Plexippus paykulli* (Audouin, 1825) ♀. 8-9. Habitus. 8. dorsal view. 9. ventral view. 10. Epigynum, ventral view (S = spermatheca).

Description of the male (Figs. 11-12)**:** Body length 8 mm, general colouration yellowish white with two dark bands on either sides of prosoma and opisthosoma (mostly with two light spots in the posterior third) (Fig. 11). Ventrally, the body is yellowish white or brownish white with a clear dark area at the opisthosoma (Fig. 12). Palpal organ: dorsally, hairy and somewhat earthy in its colouration; with a white spot in the middle; ventrally, dark with light tibia and long rather white-yellow hair, with a small sperm duct compared to *Plexippus devorans* palp (Figs. 13-14).



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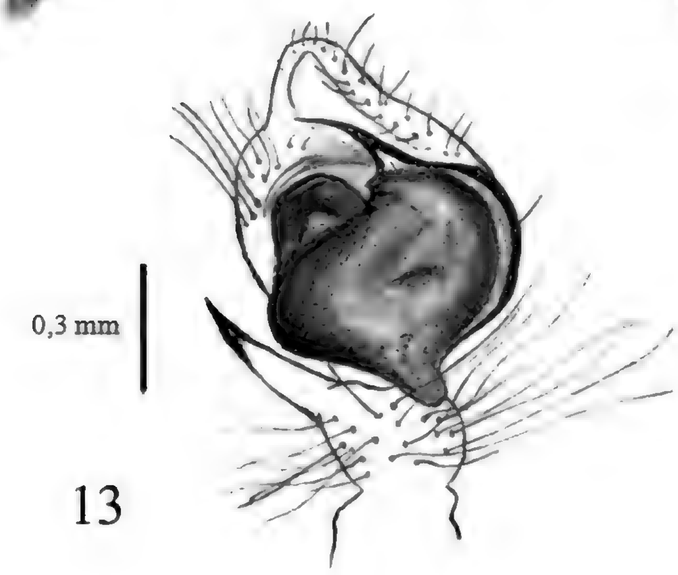

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Figs. 11-13. *Plexippus paykulli* (Audouin, 1825) ♂. 11-12. Habitus. 11. dorsal view. 12. ventral view. 13. Palpal organ, ventral view.

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Figs. 14-15. *Plexippus paykulli* (Audouin, 1825). 14. ♂ palp, ventral view. 15. ♀ epigynum, ventral view.

Discussion

The possibility that *Plexippus strandi* is a synonym of *Plexippus devorans* is very high, and unfortunately without the examination of the holotype of *P. devorans*, it will be difficult to resolve the problem decisively. Therefore, we must rely to the identical descriptions given for both species which indicate a very great similarity.

Acknowledgments

We present this work first to our friend Abderahim Elaouad, who allowed us to use the picture he took, and second to Dr. Lahsen El Ghadraoui the head of Functional Ecology and Environmental Engineering laboratory for his valuable assistance. We would like to express our sincere thanks to Dr. Robert Bosmans, Dr. Youcef Alioua, and our friend Ghassen Kmira for their valuable assistance to identify *Plexippus devorans* specimens.

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Stegodyphus semadohensis Deshmukh, 2013 is a *nomen nudum* (Araneae: Eresidae)

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Ujjwala Shivaji Deshmukh described *Stegodyphus semadohensis* based on a holotype female from the village of Semadoh in the state of Maharashtra, India (Deshmukh, 2013; note: the surname of the author is Deshmukh not Shivaji). The description is very short, and several of the figures are of poor quality. Nonetheless, the illustrations of the epigyne and vulva are sufficient enough to recognise that it is an adult female of *Stegodyphus pacificus* Pocock, 1900. This was subsequently proposed by El-Hennawy (2016), who synonymised *S. semadohensis* with *S. pacificus*. Since both sexes of *S. pacificus* were described and illustrated in an extensive revision of *Stegodyphus* Simon, 1873 by Kraus & Kraus (1989), it is hard to understand why Deshmukh (2013) only diagnosed the female of *S. semadohensis* from the more distantly related *Stegodyphus mirandus* Pocock, 1899, and failed to recognise it as a specimen of *S. pacificus*.

Regardless, it has been overlooked by El-Hennawy (2016) and the World Spider Catalog from 2015 to the present day (see World Spider Catalog, 2023) that the name *Stegodyphus semadohensis* Deshmukh, 2013 was, in any case, unavailable. Nowhere in the original description can be found a statement that the type material has been deposited in a specific collection, nor the name and location of a collection (Deshmukh, 2013). Therefore, the name is unavailable per Article 16.4.2 of the International Code of Zoological Nomenclature (ICZN, 1999). The purpose of this short note is to state that *Stegodyphus semadohensis* Deshmukh, 2013 is a ***nomen nudum***.

Of note, Deshmukh (2013) was, initially, seemingly not fully accessible or widely known to the arachnological community. It was not until 2015 that it was first indexed in the World Spider Catalog, at that time still maintained by Norman I. Platnick at the American Museum of Natural History. In this entry (Platnick, 2015) is an accompanying

note stating "only abstract seen", indicating the full work (as "Shivaji, 2013") was not able to be accessed. In version 15.5 of the Catalog – maintained from thereafter (and until the present day) by the Naturhistorisches Museum Bern following Platnick's retirement – the note added previously was omitted, and a portable document file of the work added, without recognition *S. semadohensis* was a *nomen nudum* (World Spider Catalog, 2015).

Acknowledgment

We would like to thank Theo Blick (World Spider Catalog) for commenting on this note.

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Harpactea umay sp. n., a new spider species from Türkiye (Araneae: Dysderidae)

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Abstract

Harpactea umay sp. n. is described based on both sexes from Türkiye. The new species belongs to the *rubicunda* species group as defined by Deeleman-Reinhold in 1993 and is closely related to *H. bilecenoglui* Kunt & Özkütük, 2023, *H. elvericii* Kunt & Özkütük, 2023 and *H. sanctaeinsulae* Brignoli, 1978.

Keywords: Fauna, Harpacteinae, Mediterranean, Anatolia, Türkiye.

Introduction

Harpactea Bristowe, 1939, one of the 25 known genera of the family Dysderidae, consists of 208 species generally distributed in the Mediterranean basin (World Spider Catalog, 2023).

Recently, studies on the genus *Harpactea* in and around Türkiye and the new species described have attracted attention (Bosmans & Gavalas, 2023; Kunt & Özkütük, 2023). Every newly discovered species contributes to our understanding of the species diversity of the genus, even if it has long been said that the genus requires a drastic revision (see Chatzaki & Arnedo, 2006).

The aim of this study is to describe a new species of *Harpactea* from Türkiye. The general appearance of the holotype of the new species and photographs detailing the male and female copulatory organs are here presented.

Material and Methods

All specimens were collected by pitfall traps from Konya province of Türkiye. The samples were preserved in 96% ethanol. The descriptions of the samples were made from alcohol samples caught in pitfall traps. Digital images of the pedipalp were taken with a Leica DFC295 digital camera attached to a Leica S8AP0 stereomicroscope and 5-15 photographs were taken in different focal planes and combined. All measurements are in millimetres (mm). Terminology for the body measurements follows Chatzaki & Arnedo (2006). Terminology for the copulatory organs is adapted from Deeleman-Reinhold (1993) and Platania *et al.* (2020).

The following abbreviations are used in the text and figures:

Carapace and abdomen: AL = abdominal length, CL = carapace length, Clh = clypeus height, CWmax = maximum carapace width, CWmin = minimum carapace width, TL = Total lenght. **Chelicera:** ChF = length of cheliceral fang, ChG = length of cheliceral groove, ChL = total length of chelicera (lateral external view). **Eyes:** AE = anterior eyes, AEd = diameter of anterior eyes, iAE = interdistance of anterior eyes, PLE = posterior lateral eyes, PLEd = diameter of posterior lateral eyes, PME = posterior median eyes, PMEd = diameter of posterior median eyes. **Legs:** Cx = coxa, Fe = femur, Me = metatarsus, Pa = patella, Ta = tarsus, Ti = tibia. **Spination:** d = dorsal, pl = prolateral, rl = retrolateral, v = ventral. **Male copulatory bulb:** E = embolus, T = tegulum. **Vulva:** AA = Anterior margin of the anterior arch, AC = anterior arc, PD = posterior diverticulum, RS = roundish structure, S = spermatheca, SK = spermathecal keel, TB = transversal bar. **Depository:** AZMM = Alaşehir Zoological Museum, Manisa, Türkiye.

Taxonomy

Family **Dysderidae** C.L. Koch, 1837

Genus ***Harpactea*** Bristowe, 1939

Harpactea umay sp. n. (Figs. 1-2)

Material examined: Holotype 1♂ (AZMM), Türkiye, Konya Prov., Seydişehir Dist., Geyik Mountains (37°27'24.00"N, 31°43'0.50"E), asl c. 1644 m, 22 Nov. 2016-26 Oct. 2017, Leg. E.A. Yağmur. **Paratypes** 7♂♂, 3♀♀ (AZMM) same data as holotype.

Etymology: Umay is the goddess of fertility in Turkic mythology.

Diagnosis: Males of *H. umay* sp. n. resemble those of *H. bilecenoglui* Kunt & Özkütük, 2023, *H. elvericii* Kunt & Özkütük, 2023 and *H. sanctaeinsulae* Brignoli, 1978 by the in terms of the general structure of the bulb, lack of a conductor, and spiniform embolus. In addition, there is a significant difference between the average lengths of *H. umay* sp. n. and the aforementioned species. Namely, the total length of the holotype male of *H. umay* sp. n. is 2.55, while the total lengths of the holotype males of the other species are 3.50, 4.35, and 3.87, respectively. There are also slight differences in the morphology of the bulb and embolus. In *H. bilecenoglui*, *H. elvericii*, and *H. sanctaeinsulae* the bulb is more spherical, while in *H. umay* sp. n. it is more oval and the embolus is more delicate (see Brignoli (1978) and Kunt & Özkütük (2023)). The vulva of *H. umay* sp. n. resembles that of *H. bilecenoglui* in the general structure of the anterior arc. However, there are proportional differences between the anterior, central, and posterior parts of the spermatheca between species. In *H. bilecenoglui*, the anterior part of the spermatheca is usually longer than the posterior part, whereas in *H. umay* sp. n., the lengths of both parts are almost equal (see Kunt & Özkütük (2023)).

Description: Measurements: [Holotype ♂ / Paratype ♀] TL 2.55/3.60; AL 1.40/2.25; CL 1.15/1.35; Clh 0.02/0.03; CWmax 1.00/1.10; CWmin 0.50/0.60; AEd 0.07/0.08; iAE 0.02/0.02; PLEd 0.05/0.07; PMEd 0.05/0.05; ChF 0.23/0.29; ChG 0.11/0.16; ChL 0.52/0.62.

Small-sized harpacteine spiders. Male and female individuals do not differ morphologically from one another. Leg length does not significantly differ between the sexes, despite the fact that females' body parts are clearly larger. Carapace hexagonal, brown. Fovea longitudinal and distinct. AE, PLE and PME arranged annularly. AE and PLE in contact with each other. The distance between the AE is approximately one-quarter of the diameter of the anterior eye.

Fig. 1. *Harpactea umay* sp. n. A-B. Habitus of holotype male. A. dorsal view. B. ventral view. C. Chelicerae, ventral view (red dots, promarginal; white dots, retromarginal teeth).

Sternum, labium and gnathocoxae brown. Chelicerae dark brown. Cheliceral groove with four teeth (Fig. 1C). Promarginal teeth are more strongly developed than retromarginal teeth. Of the promarginal teeth, the one at the base of the cheliceral groove is approximately twice as large as the one in the centre. The distance between the two is close to the base length of the larger one. Of the retromarginal teeth, the one in the centre of the cheliceral groove is larger than the one at the base. The distance between them is about three times their basal length.

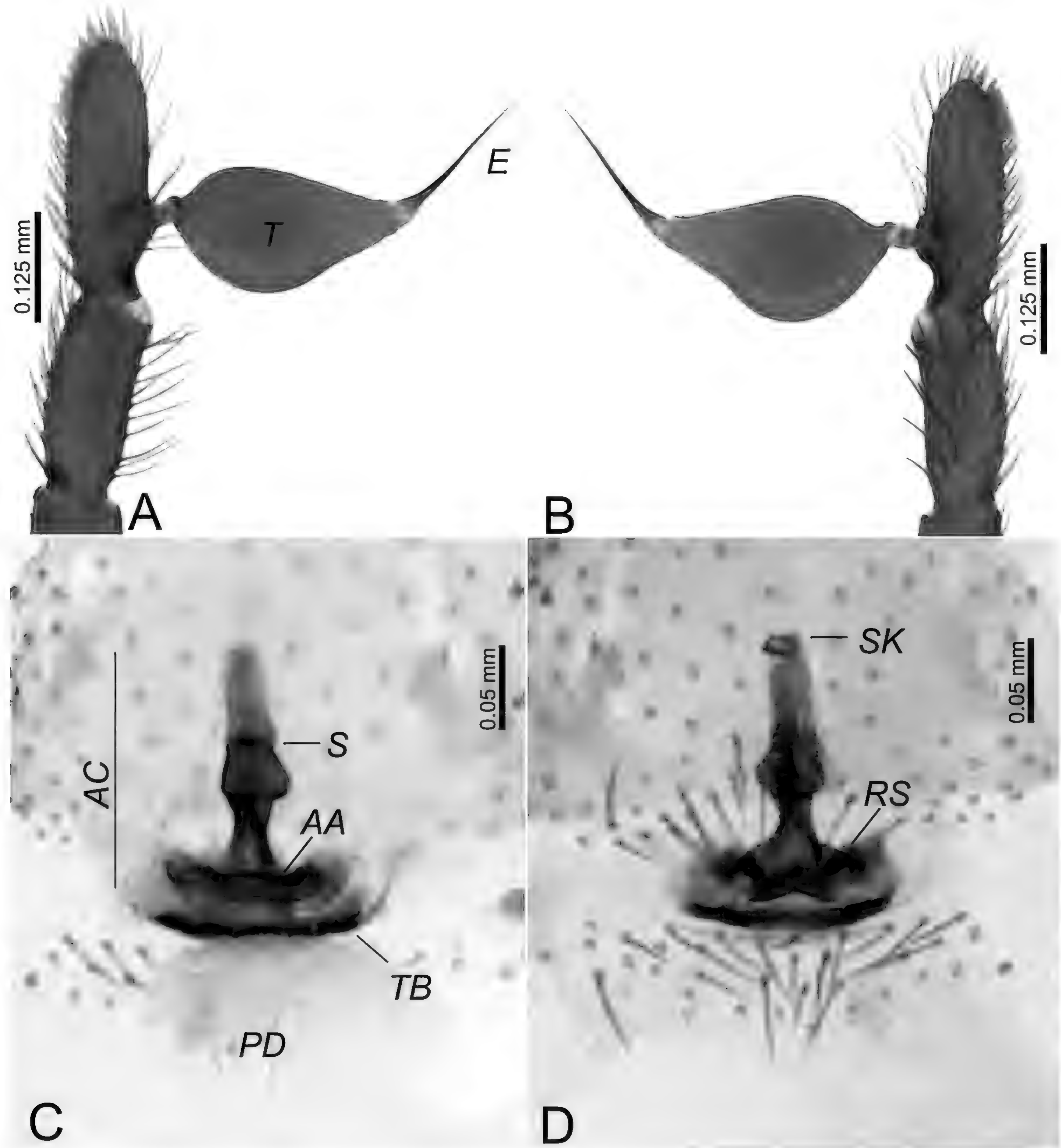

Fig. 2. *Harpactea umay* sp. n. A-B. Bulb (right). A. prolateral view. B. retrolateral view. C-D. Vulva. C. dorsal view. D. ventral view.
Abbreviations: *AA* = anterior margin of the anterior arch; *AC* = anterior arc; *E* = embolus; *PD* = posterior diverticulum; *RS* = roundish structure; *S* = spermatheca; *SK* = spermathecal keel; *T* = tegulum; *TB* = transversal bar.

Legs brownish. The anterior tarsi have very weak scopulae, while the posterior tarsi and metatarsi have weak scopulae. Prolateral side of the posterior coxae with spines. Leg formula: IV, I, II, III. Detailed leg spination and measurements are given in Tables (1-2, respectively). Abdomen and spinnerets greyish yellow.

Palp (Figs. 2A-B): palpal tarsus (0.27) slightly longer than tibia (0.23). Tegulum oval, longer than wide. Narrowing towards distally. Embolus spiniform. Tegulum (0.27) longer than embolus (0.21). Conductor and median apophysis absent.

Vulva (Figs. 2C-D): tip of spermathecal keel straight. Centre of spermatheca large, quadrangular (Fig. 2C). Posterior part of spermatheca more strongly sclerotized than anterior part. Anterior part is also longer than posterior one. Anterior margin of the anterior arch shorter than transversal bar (Fig. 2C). In dorsal view, roundish structures prominent, chevron-shaped (Fig. 2D). Transversal bar slightly concave. Posterior diverticulum distinct, membranous, approximately equal in width to length (Fig. 2C).

Table 1. Leg spination of *Harpactea umay* sp. n. (Holotype ♂ / Paratype ♀).

Legs	I	II	III	IV
♂				
Cx	0	0	1 pl	1 pl
Fe	2 pl	1 pl	2, 2 d	2 d
Pa	0	0	1 d, 1 rl	1 pl
Ti	0	0	3 pl 1 d 3 rl 1, 1, 2 v	2 pl 1, 1 d 3 rl 1, 1, 2 v
Me	0	0	3 pl 3 rl 1, 2 v	3 pl 1 d 3 rl 1, 1, 2 v
♀				
Cx	0	0	1 pl	1 pl
Fe	2 pl	1 pl	2, 2 d 1 rl	3 d
Pa	0	0	2 d, 1 rl	0-1 pl
Ti	0	0	2 pl 1 d 3 rl 1, 2 v	3 pl 1, 1 d 3 rl 1, 1, 2 v
Me	0	0	3 pl 3 rl 2 v	3 pl 1,1 d 3 rl 1, 1, 2 v

Table 2. Leg measurements of *Harpactea umay* sp. n. (Holotype ♂ / Paratype ♀).

Legs ♂/♀	I	II	III	IV
Fe	1.05/1.00	0.95/0.87	0.75/0.73	1.16/1.18
Pa	0.65/0.65	0.60/0.60	0.30/0.25	0.44/0.58
Ti	0.80/0.75	0.80/0.72	0.60/0.55	0.92/1.00
Me	0.65/0.60	0.65/0.65	0.65/0.63	1.00/1.10
Ta	0.30/0.30	0.30/0.30	0.30/0.28	0.40/0.30
Total	3.45/3.30	3.30/3.14	2.60/2.44	3.92/4.16

Distribution: Known only from type locality.

Notes

Deeleman-Reinhold (1993) divided the genus *Harpactea* into 4 groups according to the characteristics of the copulatory organs of both sexes. Based on her classification, *H. umay* sp. n. should be included in the *rubicunda* (D) group based on the structure of the male copulatory organ and the 3rd patellae and 4th coxae with spines.

This species increases the number of *Harpactea* species known from Türkiye to 36; 29 of them are endemic.

Acknowledgments

We are grateful to Dr. Sinan Anlaş, Dr. Semih Örgel, and Serkan Yaman (Manisa, Türkiye) for their help in field trips.

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Spiders as a bio-agent factor in a Mango greenhouse at Giza Governorate, Egypt

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Abstract

Spiders were collected from Mango greenhouse at Giza Governorate. There were 27 species belonging to 13 families found on ground and 11 species belonging to 6 families found on foliage. There were 22 species recorded as new locality records of Giza governorate and one species as a new record in Egypt, i.e. *Theridion hannoniae*. From these species, there are two species in terms of toxicity: *Loxosceles rufescens* and *Latrodectus geometricus*. Most families found on mango trees do not spin webs to catch their prey, they are active hunter spiders: Dysderidae, Gnaphosidae, Lycosidae, Oonopidae, Philodromidae, Salticidae, and Cheiracanthiidae. These families play an important role in reducing the pest below the economic threshold level, whereas their predators are more specialised and good hunters. Photos of external genitalia of several species are added to facilitate identification.

Keywords: Foliage habitat, ground-dwelling habitat, greenhouse, Mango, *Theridion hannoniae*, Giza, Egypt.

Introduction

Greenhouse system is one of the protected cultivation types used to produce vegetables and flowers. High-density planting is a way to get high yield in short time. The increase in area, easier harvest and pest management, and high yield in short time for high profit can be listed for the reasons to approach high-density planting (Cary, 1981).

High density culture, which allows for a greater yield in less time than traditional cultivation, is becoming more and more common in the fruit industry. By using various applications, this strategy has promoted the development of dwarf trees under controlled culture. Fruit production in greenhouses has the potential to improve fruit crops' output, quality, off-season cultivation, and exportability. In the greenhouses, you may now grow a variety of fruit trees while maintaining environmental control to guarantee a bountiful harvest. In brief, if you start with a clean greenhouse and plants, bugs shouldn't be an issue while managing insect and mite pests in greenhouses.

Stability in predator-prey systems is achieved by density-dependent responses of the predator to the prey. As prey populations increase, predation pressure should increase, and predation pressure should lessen as prey population decreases (Morin, 1999).

All spiders are predaceous and insects constitute their primary prey (Turnbull, 1973). They are generalist predators that may be of importance in reducing and even preventing outbreaks of insect pests in agriculture (Sunderland *et al.*, 1986). A diverse group of spiders may be effective in biological control because they differ in hunting strategies, habitat preferences, and active periods (Marc *et al.*, 1999). Numerous researchers have stressed that an assemblage of spider species is more effective at reducing prey densities than a single species of spider (Greenstone, 1999).

Spiders can be very helpful in controlling greenhouse pests and are important general predators. For that reason we should consider allowing them to coexist with our plants (Smith, 2000).

Material and Methods

Methods of collecting

Spiders were collected from Mango (cultivar Keitt) greenhouse. Abundance was carried out during December 2017 to May 2018 in greenhouses at Giza governorate, twice a month, by two collecting methods: a. Beating net (branch shaking), b. Hand sorting. The hand sorting method was used to pick the spider individuals around each plant or on the ground. After collecting, the specimens were picked up and kept individually in plastic vials.

Fig. 1. Mango trees inside greenhouse at Giza Governorate.

Identification and preservation of spiders

After counting the individuals of spiders, they were preserved in 70% ethyl alcohol in glass vials. Adult males and females were used to recognize the different species, while immature stages were used to recognize only the families. Genitalia of females were carefully separated and mounted in Berlese medium on microscopic glass slides for identification by using light microscope.

Table 1. Spider families found on ground below Mango trees.

Family	Behaviour	Species
Dysderidae	Do not spin web Active hunter spider	*Dysdera crocata* C.L. Koch, 1838
Gnaphosidae		*Berlandina venatrix* (O. Pickard-Cambridge, 1874)
		Micaria dives (Lucas, 1846)
		Poecilochroa pugnax (O. Pickard-Cambridge, 1874)
		Setaphis subtilis (Simon, 1897)
		Synaphosus syntheticus (Chamberlin, 1924)
		Zelotes laetus (O. Pickard-Cambridge, 1872)
Lycosidae		*Hogna ferox* (Lucas, 1838)
		Pardosa sp.
		Trochosa urbana O. Pickard-Cambridge, 1876
		Wadicosa fidelis (O. Pickard-Cambridge, 1872)
Oonopidae		*Dysderina scutata* (O. Pickard-Cambridge, 1876)
		Opopaea santschii Brignoli, 1974
Philodromidae		*Philodromus* sp.
		Pulchellodromus glaucinus (Simon, 1870)
		Thanatus fabricii (Audouin, 1825)
Salticidae		*Heliophanillus fulgens* (O. Pickard-Cambridge, 1872)
		Phlegra bresnieri (Lucas, 1846)
		Plexippus paykulli (Audouin, 1825)
Scytodidae	Do not spin web Passive spider	*Scytodes velutina* Heineken & Lowe, 1832
Sicariidae		*Loxosceles rufescens* (Dufour, 1820)
Linyphiidae	Spin web	*Agyneta rurestris* (C.L. Koch, 1836)
Oecobiidae		*Uroctea limbata* (C.L. Koch, 1843)
Synaphridae		*Synaphris letourneuxi* (Simon, 1884)
Theridiidae		*Steatoda erigoniformis* (O. Pickard-Cambridge, 1872)
		Theridion hannoniae Denis, 1945
Titanoecidae		*Nurscia albomaculata* (Lucas, 1846)

Results and Discussion

Dominance and occurrence of spider species on Mango trees in greenhouses in Giza governorate

The physiognomy or structural features of habitats has an important influence on habitat selection, and ultimately on spider species composition of habitats (Uetz, 1991). Vegetation structure, diversity, and architecture all play significant roles in habitat selection and residency (Jennings *et al.*, 1990).

During the present work, it was found that 38 spider species belonging to 17 families were collected among mango trees in greenhouses in Giza governorate.

The spiders of 14 species of seven families that spin webs were found (Dictynidae, Linyphiidae, Oecobiidae, Synaphridae, Theridiidae, Titanoecidae, and Uloboridae). The most abundant family was Theridiidae, which included eight spider species.

The spider families that do not spin webs were divided into:

a) Active hunter spiders, which included 21 species of seven families (Cheiracanthiidae, Dysderidae, Gnaphosidae, Lycosidae, Oonopidae, Philodromidae, and Salticidae). The most abundant family was Gnaphosidae which included six spider species.

b) Passive hunter spiders, which included three species of three families (Scytodidae, Sicariidae, and Thomisidae) (Table 1).

In foliage, there are six families, of which the dominant family that does not spin web, active hunter is Cheiracanthiidae, represented by one species, followed by Theridiidae, represented by six species that spin web in Table (2).

In two different habitats, there are different behaviours of these families. On the ground, there are 13 families; the dominant family that does not spin a web and is an active hunter is Salticidae, represented by three species, followed by Lycosidae, represented by four species, and the lowest family is Dysderidae represented by one species in Table (1).

From these species, there are 20 species recorded as new locality records at Giza governorate, i.e. *Agyneta rurestris*, *Berlandina venatrix*, *Dysdera crocata*, *Dysderina scutata*, *Heliophanillus fulgens*, *Latrodectus geometricus*, *Loxosceles rufescens*, *Micaria dives*, *Nigma conducens*, *Opopaea santschii*, *Phlegra bresnieri*, *Poecilochroa pugnax*, *Setaphis subtilis*, *Steatoda erigoniformis*, *Synaphosus syntheticus*, *Thanatus fabricii*, *Trochosa urbana*, *Uloborus plumipes*, *Wadicosa fidelis*, and *Zelotes laetus*.

A new record in Egypt is *Theridion hannoniae*. The dominant spider species that do not spin webs as active hunter spiders, 21 species of them are good searchers to find their prey.

Table 2. Spider families found on foliage of Mango trees.

<table>
<tr><th>Family</th><th>Behaviour</th><th>Species</th></tr>
<tr><td>Cheiracanthiidae</td><td rowspan="2">Do not spin web
Active hunter spider</td><td>Cheiracanthium isiacum O. Pickard-Cambridge, 1874</td></tr>
<tr><td>Salticidae</td><td>Thyene imperialis (Rossi, 1846)</td></tr>
<tr><td>Thomisidae</td><td>Do not spin web
Passive spider</td><td>Thomisus citrinellus Simon, 1875</td></tr>
<tr><td>Dictynidae</td><td rowspan="8">Spin web</td><td>Nigma conducens (O. Pickard-Cambridge, 1876)</td></tr>
<tr><td rowspan="6">Theridiidae</td><td>Euryopis episinoides (Walckenaer, 1847)</td></tr>
<tr><td>Kochiura aulica (C.L. Koch, 1838)</td></tr>
<tr><td>Latrodectus geometricus C.L. Koch, 1841</td></tr>
<tr><td>Theridion incanescens Simon, 1890</td></tr>
<tr><td>Theridion jordanense Levy & Amitai, 1982</td></tr>
<tr><td>Theridion melanostictum O. Pickard-Cambridge, 1876</td></tr>
<tr><td>Uloboridae</td><td>Uloborus plumipes Lucas, 1846</td></tr>
</table>

Seventeen spider families were recorded in mango cultivars (Keitt) (Table 3). Their dominances ranged from 0.2% to 20.6%. Cheiracanthiidae and Theridiidae are the

dominant families at 18.3% and 20.6%, respectively, while Dictynidae 2.1%, Dysderidae 0.2%, Linyphiidae 1.7%, Oecobiidae 0.6%, Oonopidae 1.2%, Philodromidae 4.2%, Scytodidae 2.9%, Sicariidae 1%, Thomisidae 1.7%, and Titanoecidae 0.4% are the accidental families. Gnaphosidae 10.2%, Lycosidae 9.1%, Salticidae 13.1%, Synaphridae 5.6%, and Uloboridae 7.1% are accessory families. These results are consistent with (Mohafez *et al.*, 2010) that in the collected samples of spiders from orchards of mango in Tahta district, the dominant families were Lycosidae, Gnaphosidae, and Theridiidae. In Temma district the dominant families were Lycosidae and Miturgidae (now Cheiracanthiidae).

Table 3. Dominance of spider families on Mango in greenhouse.

Family	Dominance	Dominance classification
Dysderidae	0.2	Accidental
Titanoecidae	0.4	
Oecobiidae	0.6	
Sicariidae	1.0	
Oonopidae	1.2	
Linyphiidae	1.7	
Thomisidae	1.7	
Dictynidae	2.1	
Scytodidae	2.9	
Philodromidae	4.2	
Synaphridae	5.6	Accessory
Uloboridae	7.1	
Lycosidae	9.1	
Gnaphosidae	10.2	
Salticidae	13.1	
Cheiracanthiidae	18.3	Dominant
Theridiidae	20.6	

Data given in Table (4) indicated that the family Cheiracanthiidae was the most abundant on mango in the greenhouse (100), followed by the family Theridiidae (74) as juveniles. Both spider families Dysderidae and Oonopidae were collected as adult female specimens only. And the lowest families abundant were Titanoecidae, Oecobiidae, and Linyphiidae (1, 4, 7), respectively.

One hundred twenty-five adult individuals (49 ♂, 76 ♀) were collected, representing 35 species belonging to 15 families. The family Theridiidae, with eight species: *Euryopis episinoides*, *Kochiura aulica*, *Latrodectus geometricus*, *Steatoda erigoniformis*, *Theridion incanescens*, *T. jordanense*, *T. melanostictum*, and *T. hannoniae*, was the most frequent family, followed by Synaphridae with one species, *Synaphris letourneuxi*, and the family Salticidae with four species, *Heliophanillus fulgens*, *Phlegra bresnieri*, *Plexippus paykulli*, and *Thyene imperialis*. Even if collecting was not strictly standardised, some differences in abundance and frequency were obvious. The most frequent species in mango greenhouse was *Synaphris letourneuxi*, but the most abundant species were *Kochiura aulica* and *Theridion incanescens*. The two most important species of spiders in terms of toxicity are *Loxosceles rufescens* and *Latrodectus geometricus*, which were recorded in Giza governorate as a new locality.

Table 4. Occurrence of spider families as juveniles and adults of Mango trees in greenhouse during six months.

Family	Months of collecting						Total number of juveniles	Number of adults
	Dec.	Jan.	Feb.	Mar.	Apr.	May		
Cheiracanthiidae	22	24	18	12	8	16	100	7
Dictynidae	1	3	2	1	1	0	8	4
Gnaphosidae	3	13	4	13	5	6	44	13
Linyphiidae	0	1	3	1	1	1	7	2
Lycosidae	15	11	4	7	4	20	61	8
Oecobiidae	1	1	0	1	1	0	4	0
Philodromidae	4	5	2	3	1	0	15	4
Salticidae	12	14	10	11	0	0	47	16
Scytodidae	1	4	0	4	4	0	13	5
Sicariidae	0	1	1	4	3	3	12	0
Synaphridae	3	1	1	2	2	1	10	15
Theridiidae	17	14	9	16	14	4	74	42
Thomisidae	1	0	0	3	3	3	10	4
Titanoecidae	1	0	0	0	0	0	1	1
Uloboridae	9	12	5	1	0	12	39	4

Taxonomical characters of male and female genitalia

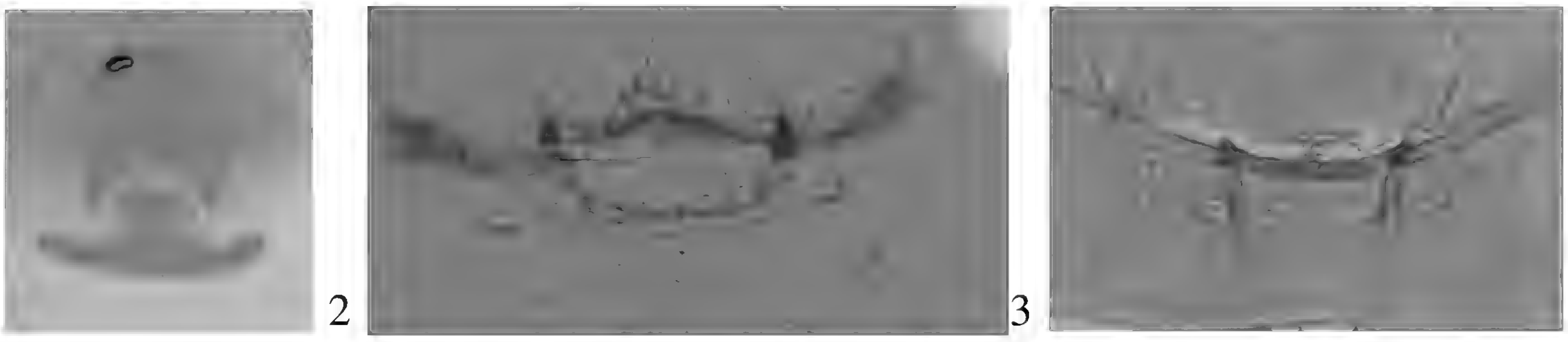
The external sexual organ is often so specific to a species that systematists use them as decisive characters for species identification. In the haplogyne male spiders the simplest form of a palp is seen. The tarsus of the palp (cymbium) carries an extension in the form of pear-shaped bulb, or palpal organ. The male palps are much more complex in entelegyne spiders because the wall of the palpal organ consists of hard, sclerotized parts and soft area; both can bear special protrusions which play an essential role during copulation.

In haplogyne female spiders, the spermathecae are typically blind sacks connected to a duct or stalk, in entelegynes at least one spermatheca on each side connects to both the copulatory and the fertilization ducts. Entelegynes usually have two pairs of ball-shaped receptacles, the primary and secondary spermathecae (Foelix, 1996).

During the present study several families were collected, males and females genitalia were separated to identify spider species. Photos of external genitalia of several species are added below to facilitate identification.

Haplogyne families

Here, there are three families of this group of spiders: Dysderidae, Oonopidae, and Scytodidae (Figs. 1-4).



Figs. 1-3. ♀ genitalia. 1. **Family Dysderidae**, *Dysdera crocata*. 2-3. **Family Oonopidae**, 2. *Dysderina scutata*. 3. *Opopaea santschii*.

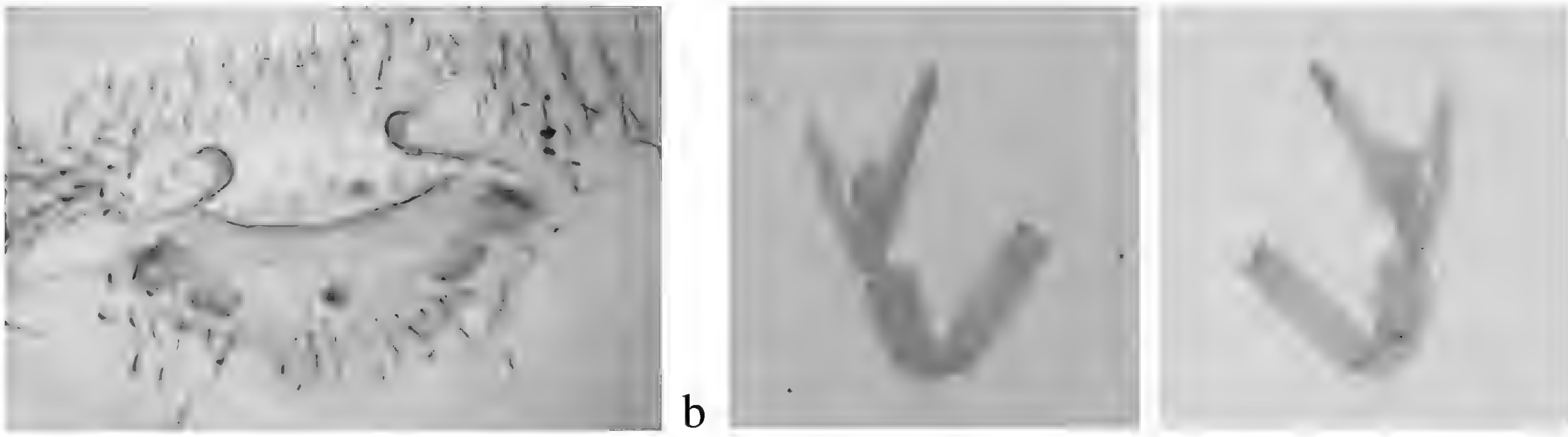


Fig. 4a-b. **Family Scytodidae**, *Scytodes velutina*. a. ♀ genitalia. b. ♂ palp, lateral views.

Entelegyne families

In this work, there are 12 families of this group of spiders: Cheiracanthiidae, Dictynidae Gnaphosidae, Linyphiidae, Lycosidae, Philodromidae, Salticidae, Synaphridae, Theridiidae, Thomisidae, Titanoecidae, and Uloboridae (Figs. 5-29).

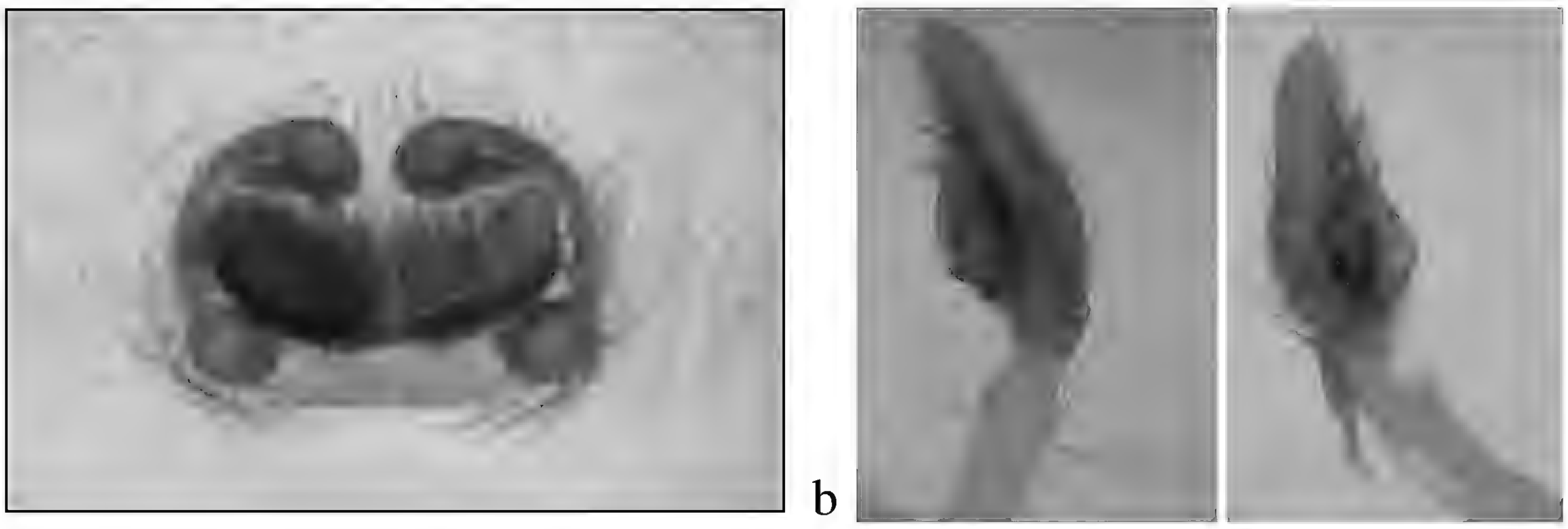


Fig. 5a-b. **Family Cheiracanthiidae**, *Cheiracanthium isiacum*. a. ♀ epigynum, ventral view. b. ♂ palp, lateral views.

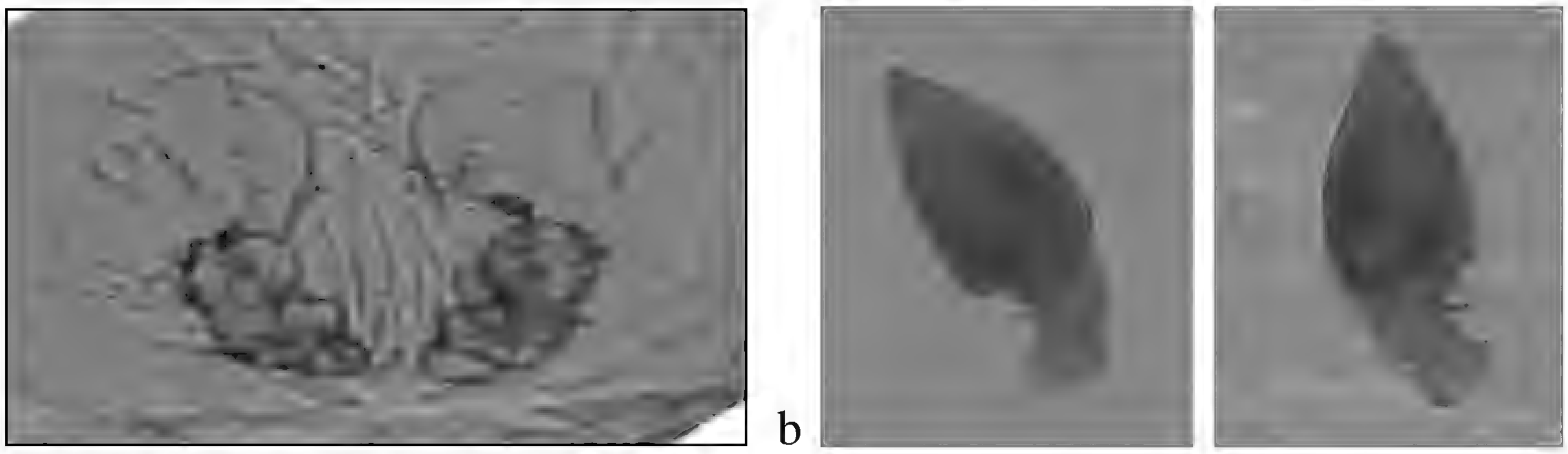


Fig. 6a-b. **Family Dictynidae**, *Nigma conducens*. a. ♀ epigynum, ventral view. b. ♂ palp, retrolateral and ventral views.

Figs. 7-11. **Family Gnaphosidae**

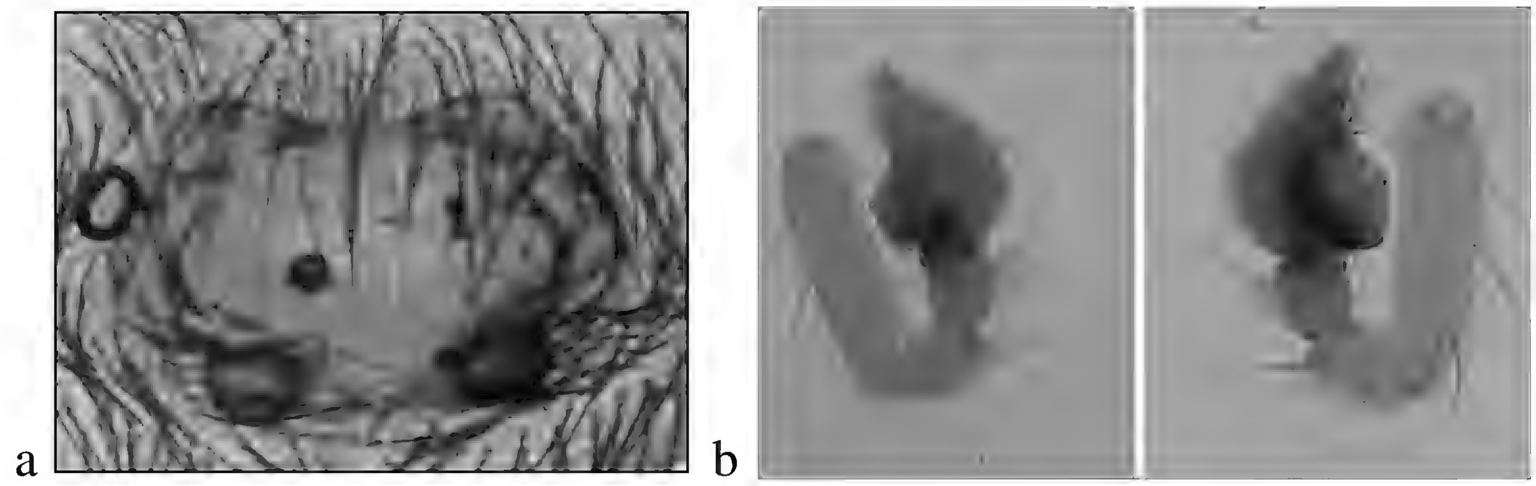
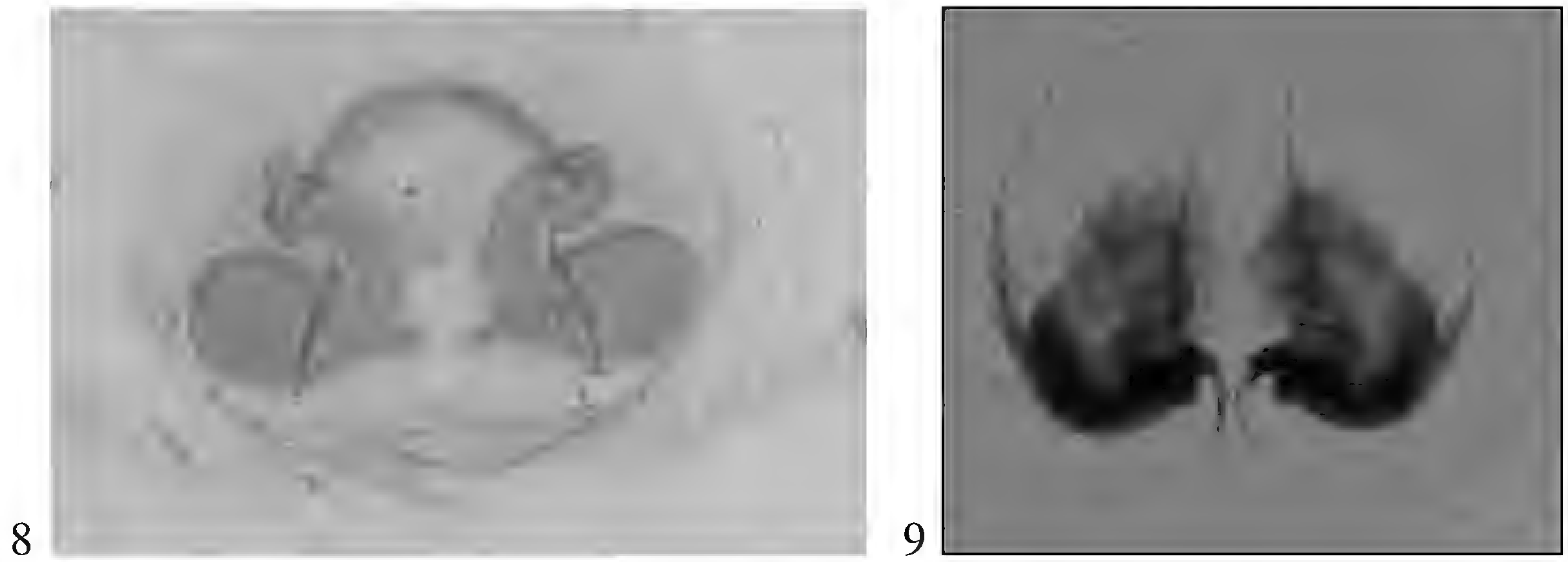


Fig. 7. *Berlandina venatrix*. 1a. ♀ epigynum, ventral view. b. ♂ palp, lateral views.



Figs. 8-9. ♀ epigynum, ventral view. 8. *Micaria dives*. 9. *Poecilochroa pugnax*.

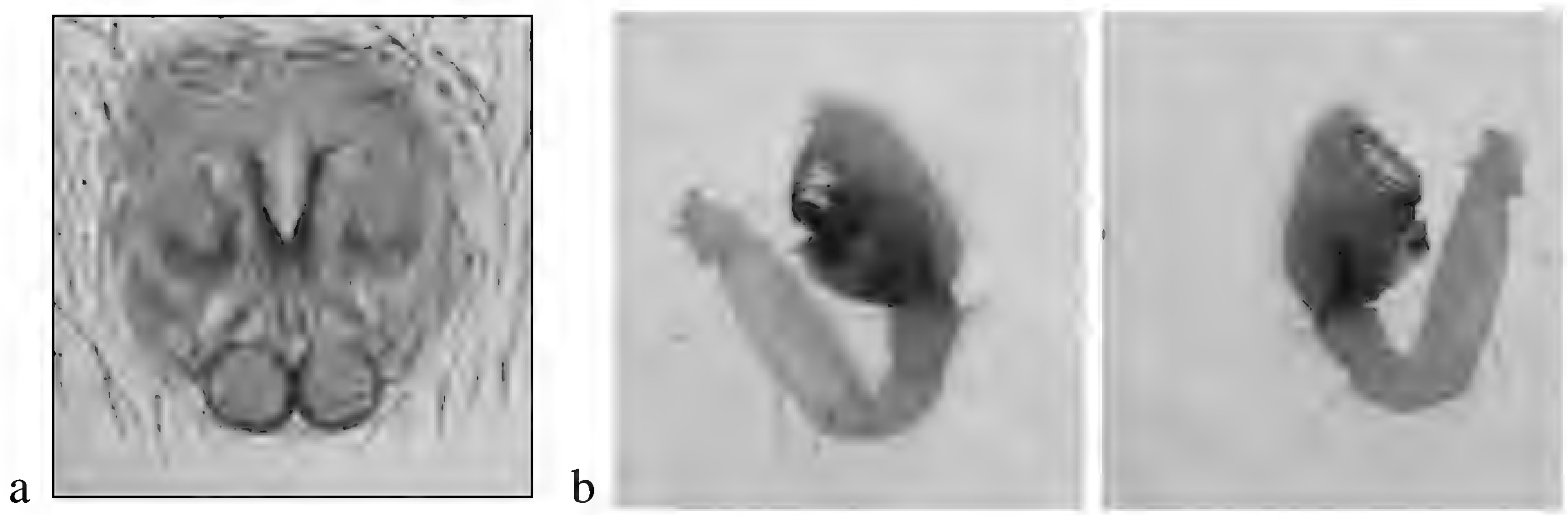


Fig. 10. *Setaphis subtilis*. a. ♀ epigynum, dorsal view. b. ♂ palp, lateral views.

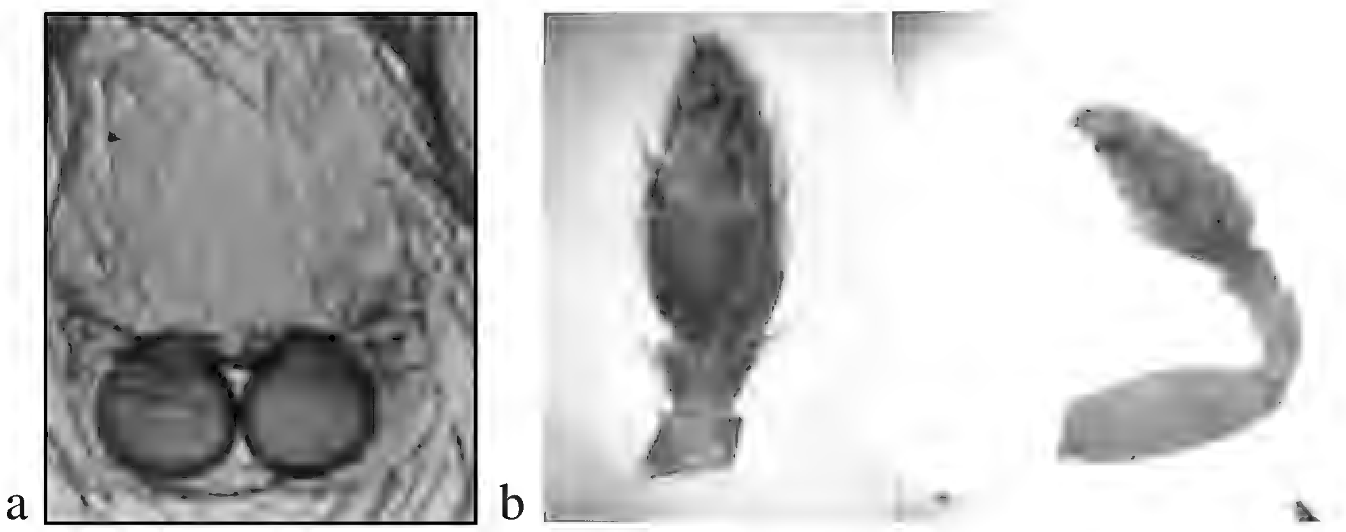


Fig. 11. *Zelotes laetus*. a. ♀ epigynum, dorsal view. b. ♂ palp, mesoventral and retrolateral views.

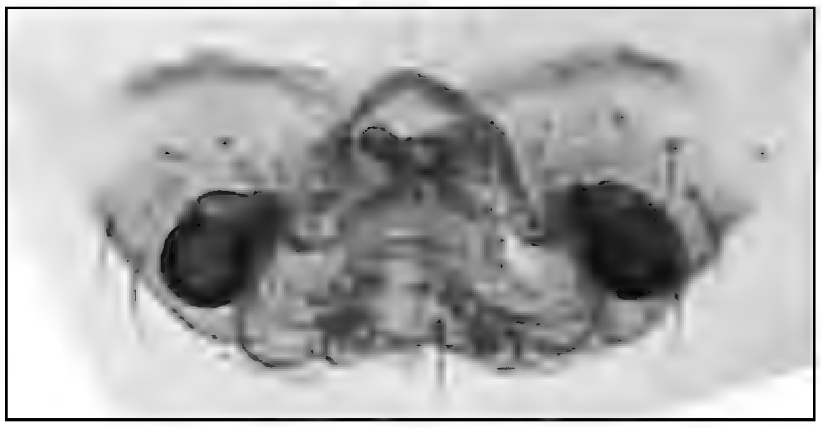


Fig. 12. **Family Linyphiidae**, *Agyneta rurestris*, ♀ epigynum, ventral view.

Figs. 13-15. **Family Lycosidae**

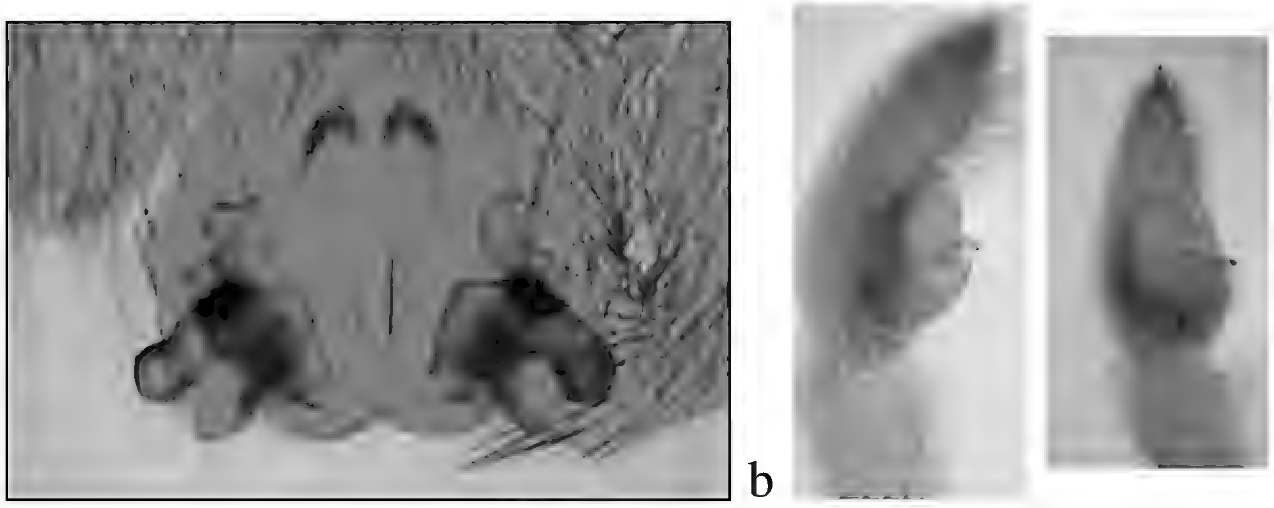
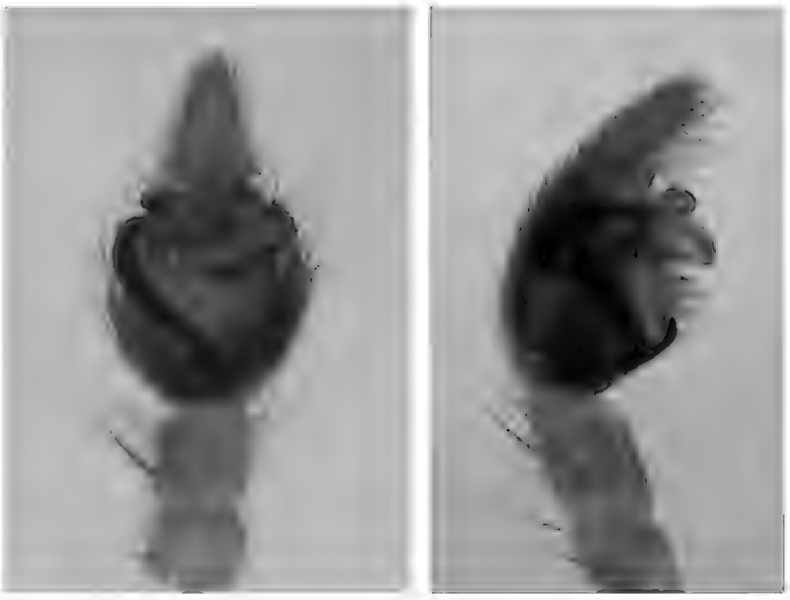
a  b

Fig. 13. *Hogna ferox*. a. ♀ epigynum, dorsal view. b. ♂ palp, lateral and ventral views.

14  15 

Figs. 14-15. ♂ palp, lateral and ventral views. 14. *Trochosa urbana*. 15. *Wadicosa fidelis*.

Fig. 16. **Family Philodromidae**, *Pulchellodromus glaucinus*, ♀ epigynum, dorsal view.

Figs. 17-18. **Family Salticidae**

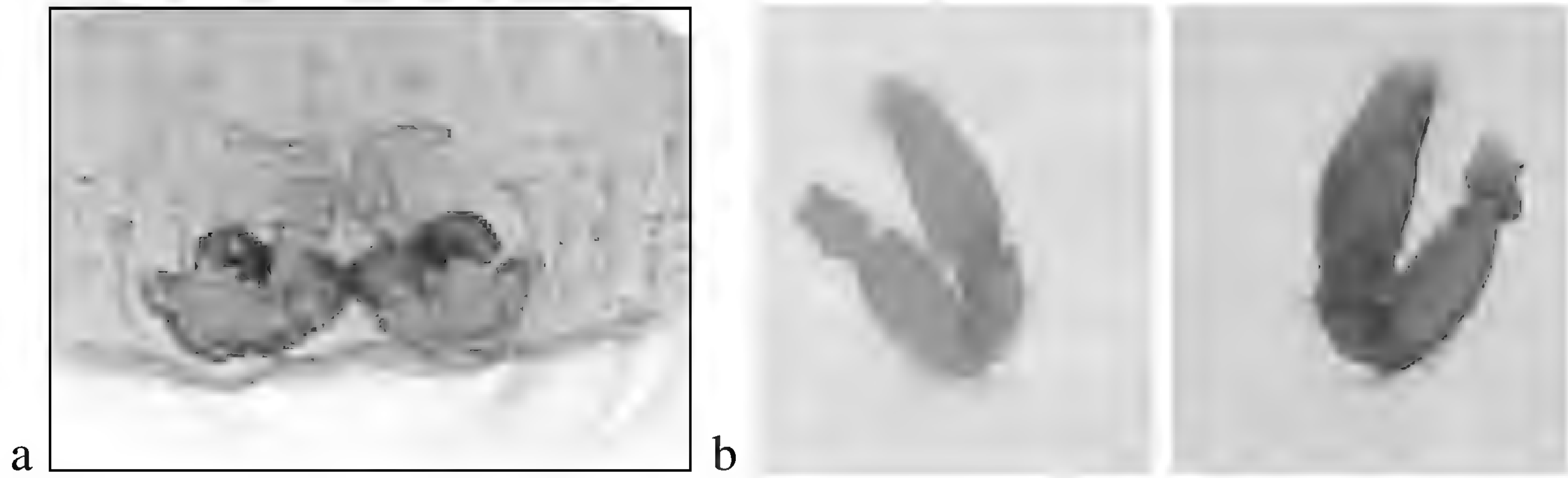


Fig. 17. *Heliophanillus fulgens*. a. ♀ epigynum, dorsal view. b. ♂ palp, retrolateral and mesoventral views.

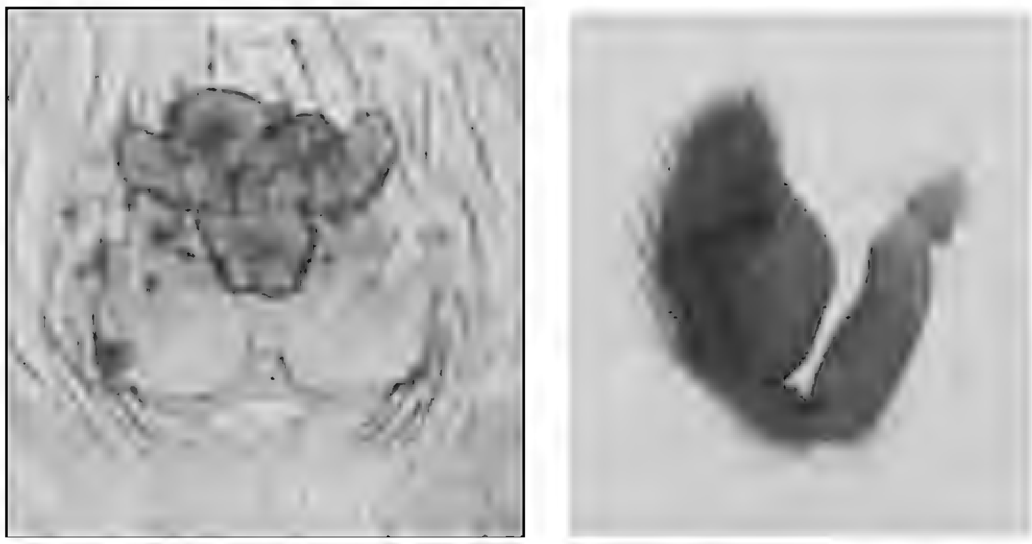


Fig. 18. *Phlegra bresnieri*. a. ♀ epigynum, dorsal view. b. ♂ palp, retrolateral view.

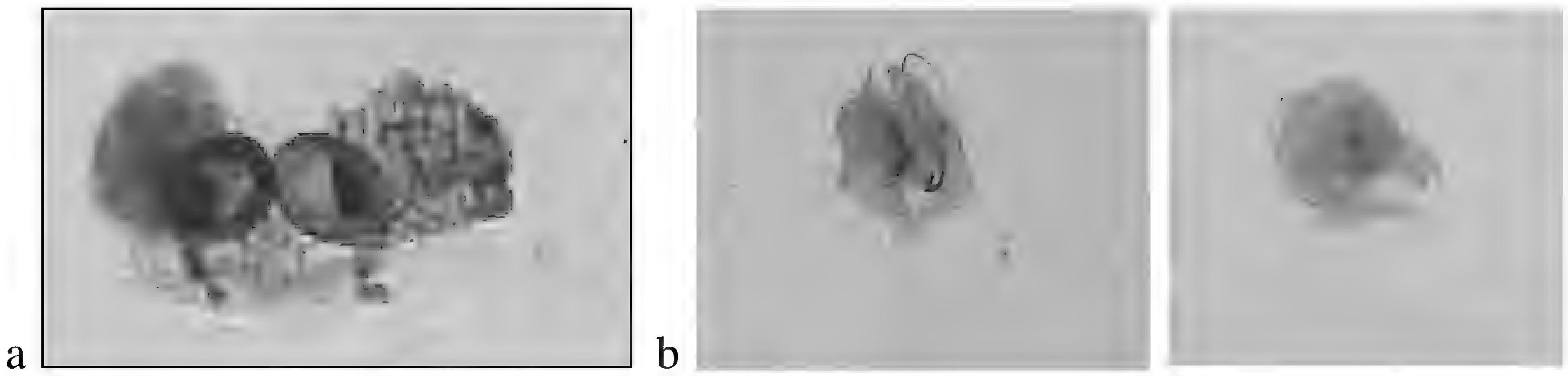


Fig. 19. **Family Synaphridae**, *Synaphris letourneuxi*. a. ♀ genitalia, dorsal view. b. ♂ palp, retrolateral and ventral views.

Figs. 20-26. **Family Theridiidae**

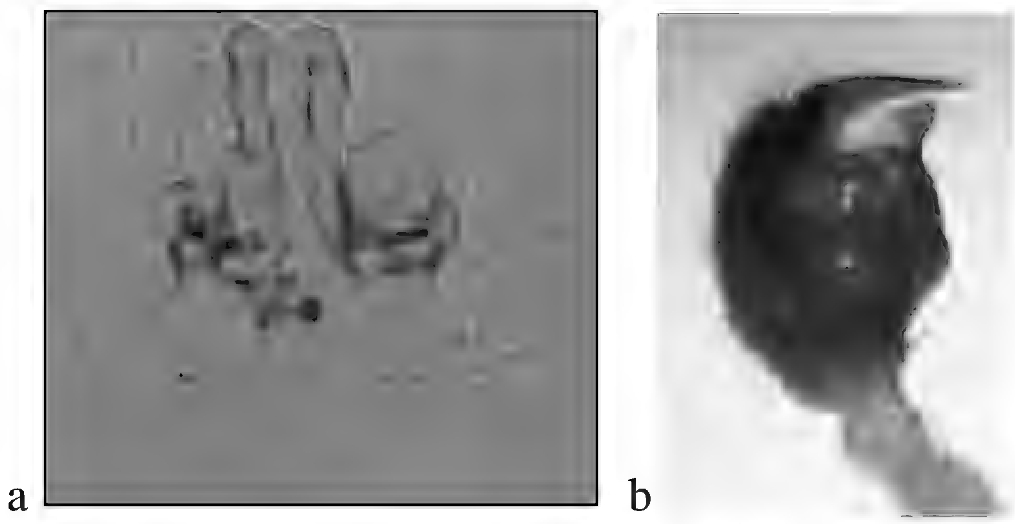


Fig. 20. *Euryopis episinoides*. a. ♀ genitalia, dorsal view. b. ♂ palp, retrolateral view.

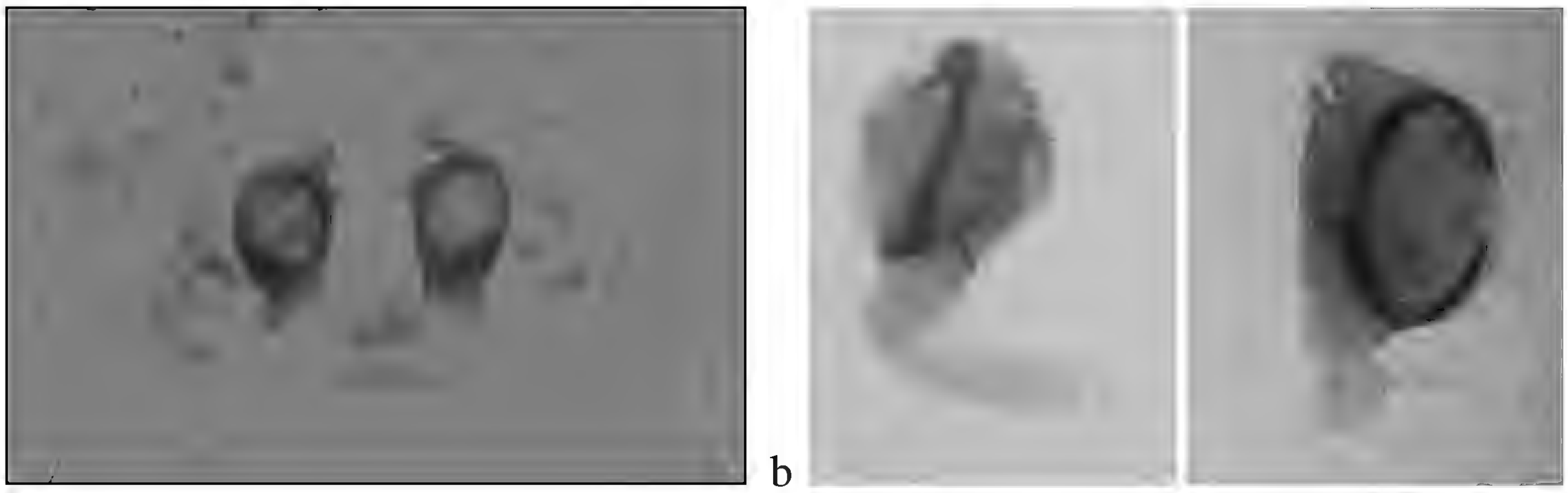


Fig. 21. *Kochiura aulica*. a. ♀ genitalia, dorsal view. b. ♂ palp, lateral views.

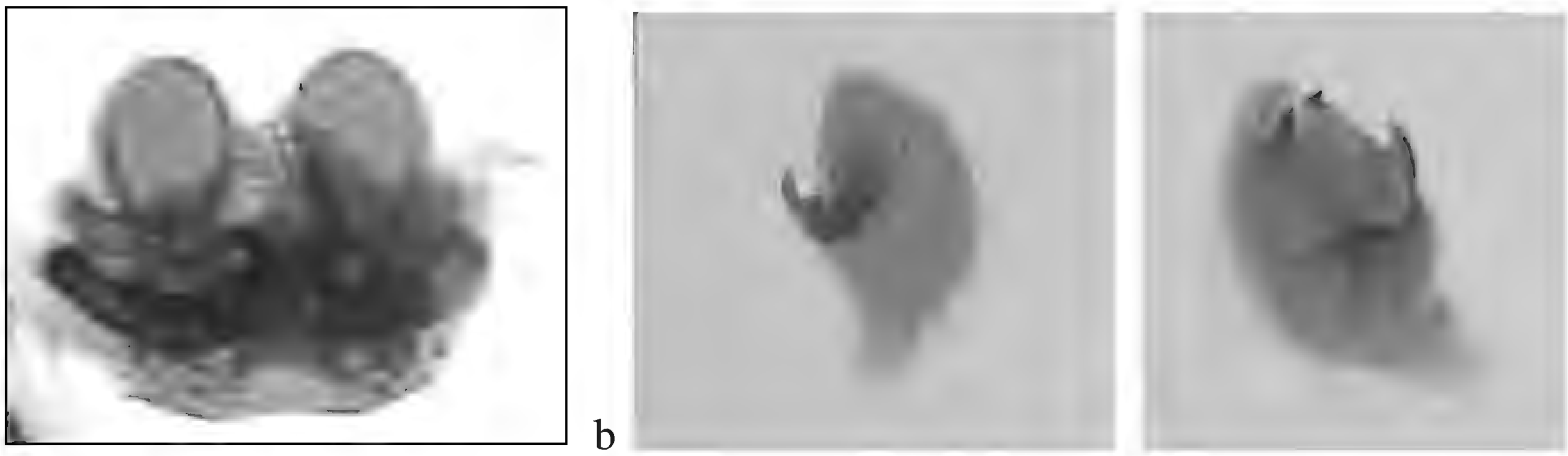


Fig. 22. *Theridion hannoniae*. a. ♀ epigynum, ventral view. b. ♂ palp, retrolateral and mesoventral views.

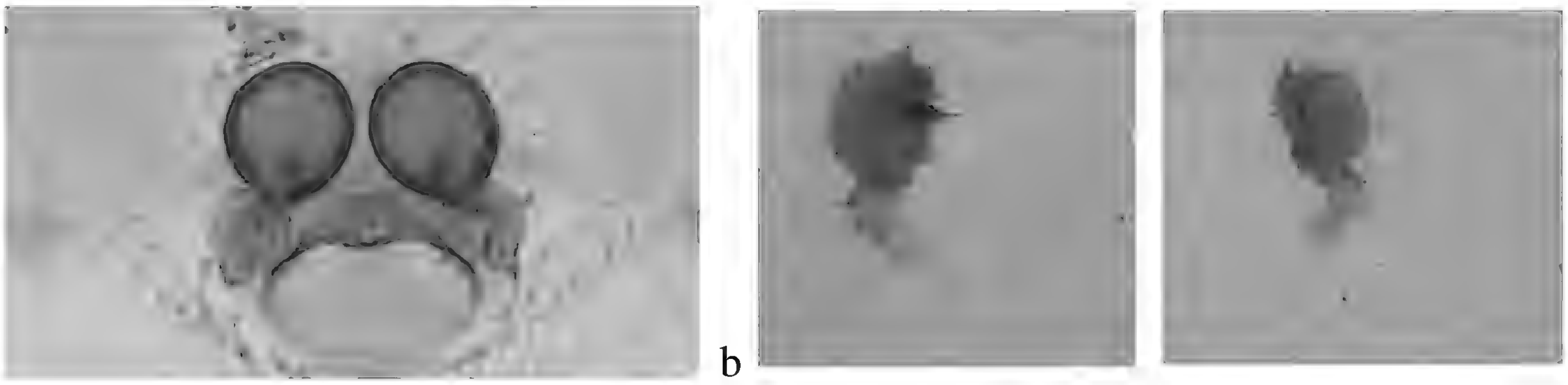
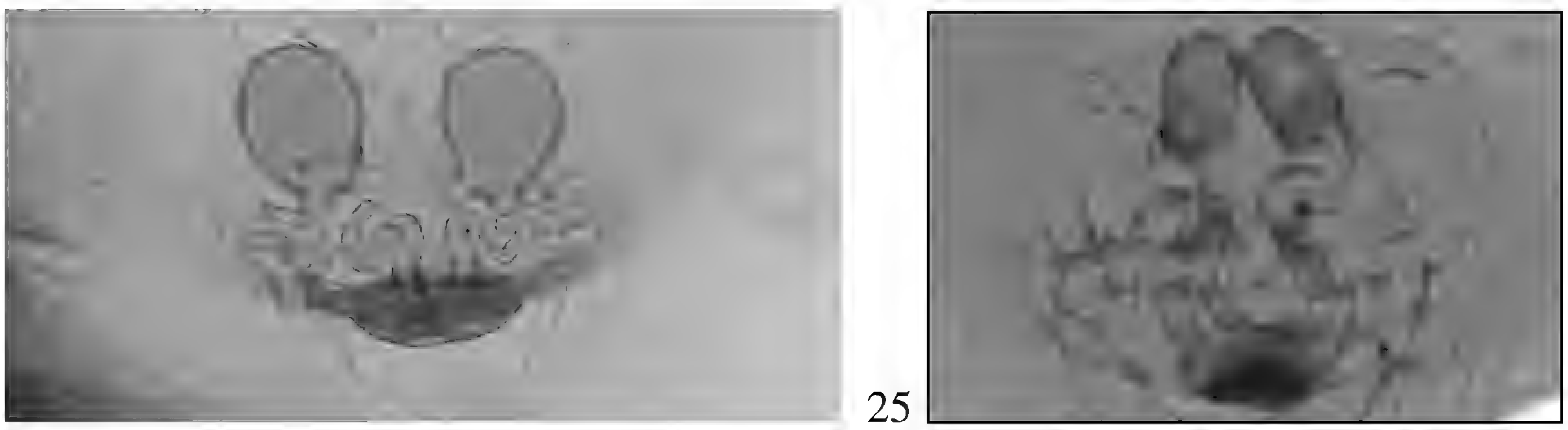


Fig. 23. *Theridion incanescens*. a. ♀ epigynum, ventral view. b. ♂ palp, lateral views.



Figs. 24-25. ♀ genitalia, dorsal view. 24. *Theridion jordanense*. 25. *Theridion melanostictum*.

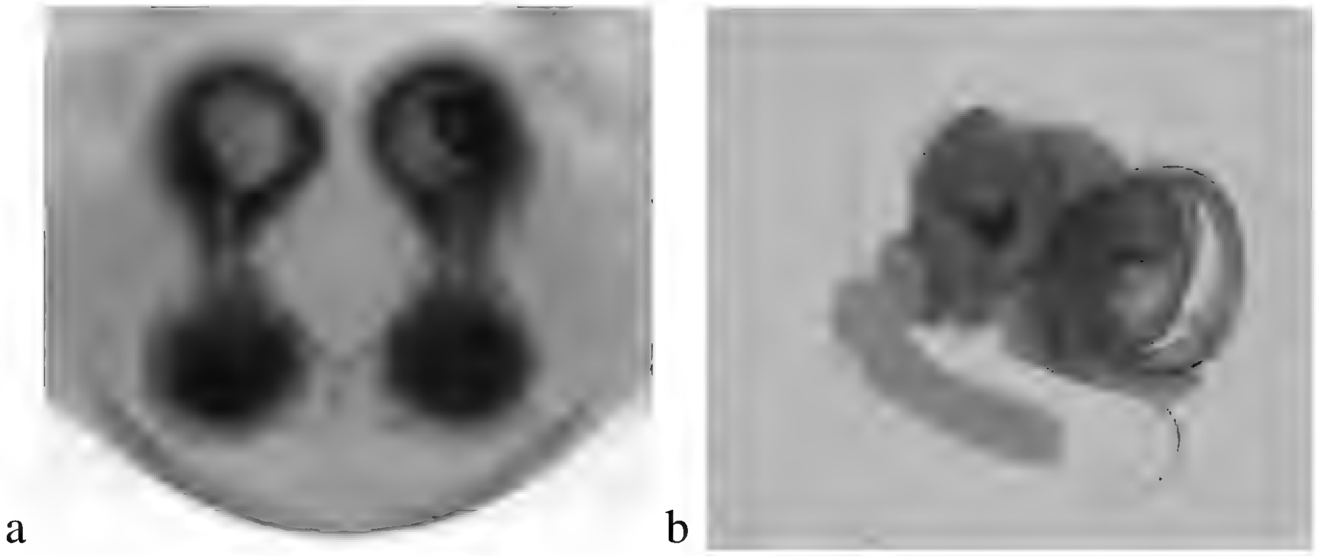


Fig. 26. *Latrodectus geometricus*. a. ♀ epigynum, dorsal view. b. ♂ palp, retrolateral view.

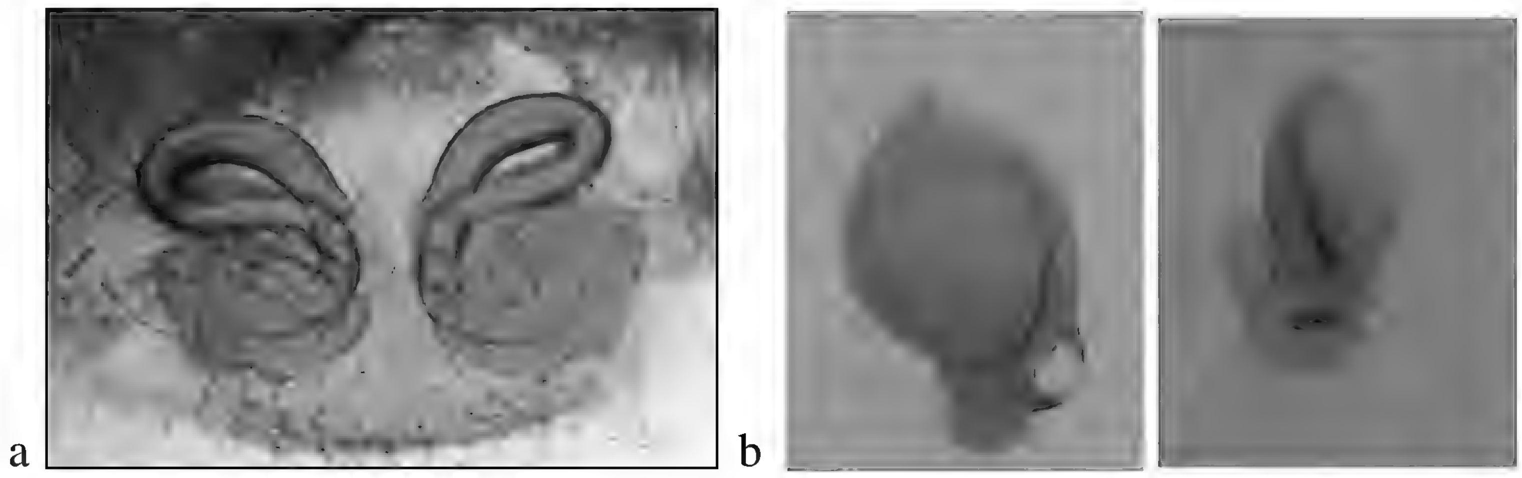


Fig. 27. **Family Thomisidae**, *Thomisus citrinellus* [*T. spinifer*]. a. ♀ genitalia, dorsal view. b. ♂ palp, ventral and retrolateral views.

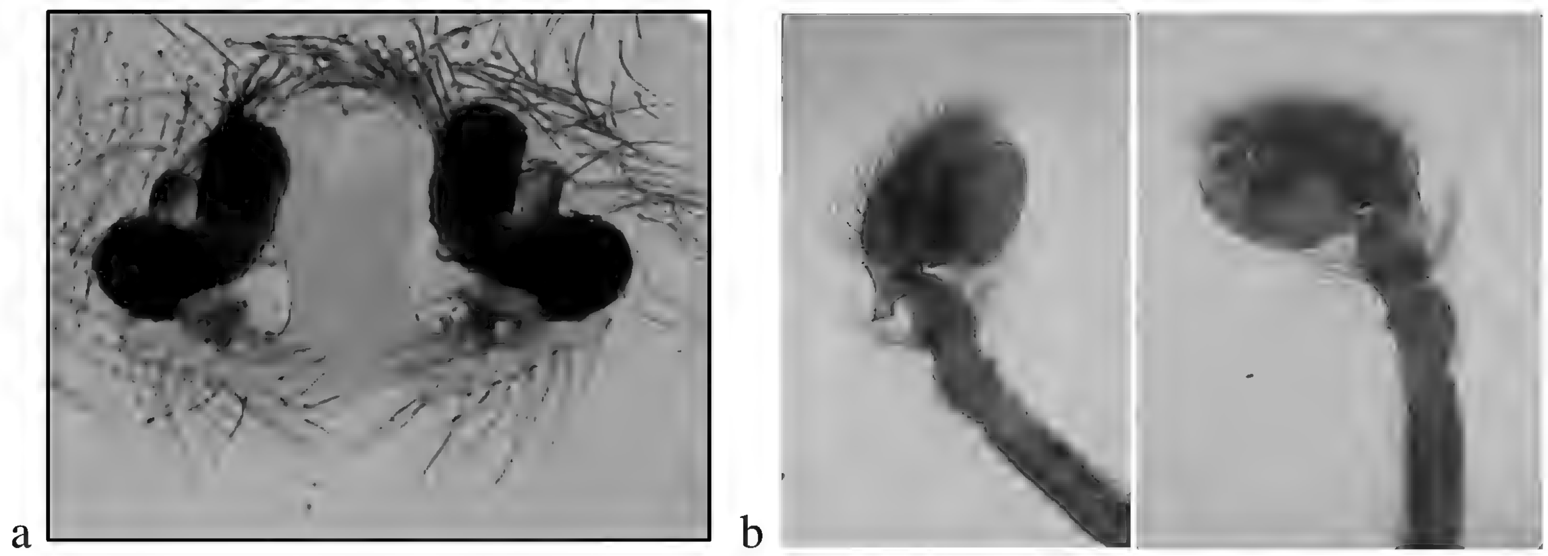


Fig. 28. **Family Titanoecidae**, *Nurscia albomaculata*. a. ♀ genitalia, ventral view. b. ♂ palp, lateral views.

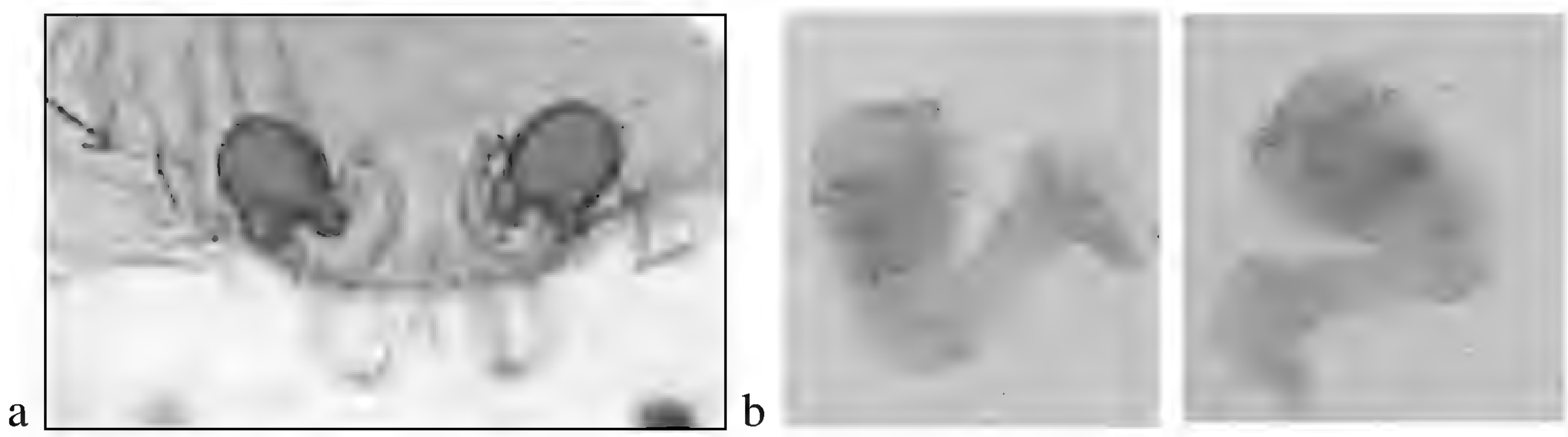


Fig. 29. **Family Uloboridae**, *Uloborus plumipes*. a. ♀ genitalia, dorsal view. b. ♂ palp, retrolateral and ventral views.

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DNA barcode and phylogenetic analysis for the araneid spider *Neoscona theisi* (Walckenaer, 1841) (Arachnida: Araneae: Araneidae) from India

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Abstract

Present study reports the orb-weaver spider *Neoscona theisi* (Walckenaer, 1841) from the Northern Western Ghats, India with its DNA barcode studies and a preliminary phylogenetic analysis. Although the species is taxonomically well established with wide range of distribution, DNA barcode with verifiable voucher specimen in a National Repositories are wanting. In the data driven era and metabarcoding, DNA barcode library with verifiable voucher specimens are crucial. In the present account taxonomic account of the species is revisited, along with DNA barcode and discussion are made on the utility of DNA barcodes and reference barcode library.

Keywords: Araneidae, *Neoscona theisi*, DNA Barcode library, Phylogeny, northern Western Ghats, India.

Introduction

Spiders constitute a varied group of invertebrates with archaeological records dating back to the Devonian period and having ancient evolutionary history (Tyagi *et al.*, 2019). Araneid spiders, also known as orb-weaving spiders, are a family of spiders classified under the family Araneidae. These spiders are known for their intricate, circular-shaped webs that they use to capture prey. These spiders are generally nocturnal and rebuild their webs each night. They exhibit a remarkable ability to sense vibrations on their webs, allowing them to detect prey or potential threats.

Araneid spiders are found worldwide, except in extremely cold regions. The current world count of spiders has 51,784 species of 136 families (World Spider Catalog, 2023). They typically prefer areas with vegetation and places where their webs are less likely to be disturbed.

Neoscona Simon 1864 is a genus of spiders belonging to the family Araneidae. These spiders are commonly known as "spotted orb-weavers" or "spotted garden spiders." The genus *Neoscona* has a wide distribution across various regions, including North America, Europe, Asia, Africa, and Australia (World Spider Catalog, 2023). These spiders are medium to large-sized orb-weavers. They typically have a round abdomen with a range of colours, including shades of brown, yellow, or grey. One distinctive feature of *Neoscona* spiders is the presence of spots or markings on their abdomen called sigilla which can vary in pattern and colouration among different species. Genus *Neoscona* is represented by 32 species known from India (Table 1).

Pioneer studies on spider's documentation from India has been by Tikader from 1980's and since then the number of species recorded till date has increased from 1067 species in 1987 to present day reported diversity comprised in 61 families, 495 genera with 1954 species (Caleb & Sankaran, 2023). The present diversity of 1954 species may be under representation of the group from India, as most of the studies are limited to morphology-based reports or checklists with poor representation of the group on genetic scale from India. In the present era of DNA barcoding there are marginal studies encompassing the genetic studies on this diverse class of arachnids. Despite of being a megadiverse country harbouring rich diversity of life forms, the rate of species documentation from India is slow which needs to be paced up in the immediate future for which DNA barcodes represent a handy tool.

DNA barcodes having the potential of species delimitation will help in filling the gaps of faunal documentation and improve our current understanding of faunal diversity, distribution, and related aspects, additionally it will aid in future in identification and other studies when actual specimen collection may be a limitation. DNA barcoding studies from a taxonomically identified voucher specimens in India are still in upcoming stages in many groups especially among arthropods including spiders (Tyagi *et al.,* 2019). Only countable studies exist at present (Dinesh *et al.*, 2023; Tyagi *et al.*, 2019; Gaikwad *et al.*, 2017) in context to spiders documentation in aid with DNA barcodes from India, while spider's documentation from the global biodiversity hotspot, the Western Ghats outlining the western peninsula of India is negligible and remains poorly explored. As suggested by Robinson *et al.* (2009) DNA barcodes not only assist in species identity confirmation but also plays a significant role in resolving taxonomic uncertainties. Hence it becomes necessary to have DNA barcode data in a group as vast as that of spiders from the Western Ghats which is substantially reported to inhabit endemic and unique lineages.

DNA barcoding is a valuable tool for specimen identification and species discovery of Indian spiders by detection of cryptic species and species complex (Tyagi *et al.*, 2019). The morphological identification and analysis are tedious and time-consuming tasks due to sexual dimorphism, polymorphism, morphological variations and lack of identification keys for juveniles (Coddington & Levi, 1991; Magalhaes *et al.*, 2017). DNA barcoding is a very useful and emerging technique to overcome these hurdles for identification (Hebert *et al.*, 2003). This tool is widely used in biodiversity research, as it provides accurate species identification (Hebert *et al.*, 2003). DNA barcoding has emerged as an additional tool for taxonomy and as an aid to taxonomic impediments (Gaikwad *et al.*, 2017). Gaikwad *et al.* (2017) had conducted DNA barcoding study of spiders from India which included 17 morphologically identical species. Wheeler *et al.*

(2017) studied the spider tree of life, phylogeny of Araneae based on target-gene analyses from an extensive taxon sampling.

The present study is an attempt to report a species of *Neoscona* from the Northern Western Ghats (NWG) with its DNA barcode, and the phylogeny of *Neoscona* is provided to affirm the genetic identity and discussion are made on the utility of DNA barcodes and reference barcode library.

Material and Methods

Specimens Collecting: The specimens were collected from the campus of Zoological Survey of India (ZSI), Western Regional Centre (WRC), Pune (18.648 N, 73.760 E; altitude 580 m) as a part of training under Green Skill Development Program (GSDP) on 06.09.2018 by Shazia Quasin. The specimens are deposited in the National Zoological Collection (NZC) of ZSI, WRC, Pune (ID. Register No. Ar/715).

Molecular studies: DNA isolation was performed from a single leg using DNeasy Blood and Tissue Kit (Qiagen) as per the manufacturer's protocol, followed by quantitation utilizing the HS dsDNA assay kit on Qubit 2.0 fluorometer. Amplification of the mt COI gene was performed using Folmer's universal primer, LCO1490 and HCO2198 (Folmer *et al.*, 1994) in 25µL reaction volume constituted by 12.5 µL of 2X Go Taq Hot Start Master Mix (Promega), 0.4µM of each forward and reverse primer along with 50mg of template DNA and Nuclease free water up to Q.S. Thermal cycling profile included one cycle of denaturation at 95°C for 2 mins, followed by 35 cycles of initial denaturation at 95°C for 0.5 minutes, annealing at 47-49°C for 45 secs, and extension at 72°C for one min; and final extension at 72°C for 5 minutes. Amplified PCR product was confirmed by Gel Electrophoresis stained by SYBR safe DNA gel stain (Invitrogen), and visualized under UV by Gel Documentation system. Amplified PCR products were purified by Invitrogen's Pure Link PCR Purification Kit. Purified PCR product was outsourced for bidirectionally Sanger's sequencing to Barcode Biosciences Pvt Ltd, Bangalore.
Obtained chromatograms were manually checked for quality and corrections. Additionally, 784 mt COI sequences of *Neoscona* were downloaded from the GenBank, of which only two sequences per species were kept, except for the species of our interest while rest of the sequences were excluded from the analysis. Sequence alignment, name editing, and translation checking were performed in MEGA XI software (Tamura *et al*, 2021). Maximum Likelihood analysis was built in IQ tree webserver with 1000 ultrafast bootstraps and SH-aLRT branch test under TIM2+F+I+G4 model auto selected according to Bayesian Information Criterion (BIC) with 220 sequences (Appendix 1). Resultant tree was visualized by Fig Tree v1.4.0 treating species *Araneus* as out group following Xu *et al.* (2019) and Tyagi *et al.* (2019).

The present collection from Pune was identified as *Neoscona theisi* based on the literature studies as well as DNA barcode studies.

Abbreviations used in the text: AL = abdomen length, ALE = anterior lateral eye, AME = anterior median eye, AW = abdomen width, CL = carapace length, CW = carapace width, PLE = posterior lateral eye, PME = posterior median eye, sps. = group of different species of the same genus, TL = total length. Leg measurements: TL (Femur, Patella, Tibia, Metatarsus, Tarsus). All measurements are in millimetres (mm).

Results

Systematic Account

Kingdom Animalia
Phylum Arthropoda
Subphylum Chelicerata
Class Arachnida
Order Araneae
Infraorder Araneomorphae
Family Araneidae
Genus *Neoscona*
Species ***Neoscona theisi*** (Walckenaer, 1841)

Epeira theis Walckenaer, 1841
For all synonyms, see the World Spider Catalog (2023).

Material Examined: ID. Reg. No. Ar/715 (NZC: ZSI WRC Pune), 1 female, ZSI Akurdi Campus, 06.09.2018, Coll. S. Quasin.

Measurements (female): TL 7.57, CL 2.79, CW 2.64, AL 4.79, AW 3.86.
Interocular distance: AME-AME 0.36, ALE-AME 0.50, ALE-ALE 1.21, PME-PME 0.21, PLE-PME 0.57, PLE-PLE 1.25, ALE-PLE 0.11, AME-PME 0.18 Legs: I 12.57 (3.29, 1.43, 3.00, 3.71, 1.14); II 9.57 (1.86, 1.14, 2.71, 3.00, 0.86); III 6.43 (1.71, 1.00, 1.29, 1.57, 0.86); IV 12.29 (3.43, 1.43, 2.86, 3.57, 1.00). Leg formula 1423.

Morphological Description
Diagnostic Characters (Fig. 1)
Colouration: Cephalothorax and legs yellowish brown, abdomen brownish white.
Cephalothorax: longer than wide, narrowing in front, clothed with pubescence and hairs, provided with two lateral and one rnedian longitudinal dark brown bands; thoracic region provided with distinct longitudinal groove. Ocular quad longer than wide and wider in front than behind. Anterior median eyes larger than posterior medians; lateral eyes close; both rows of eyes slightly recurved. Sternum heart-shaped, pointed behind, clothed with pubescence and hairs, dark brown, provided with a conspicuous mid-longitudinal bar. Labium wider than long, dark brown. Maxillae longer than wide, dark brown in colour but anterior border pale, distal end provided with scapulae. Chelicerae strong, light brown with prominent boss. Legs long and strong, clothed with hairs and spines, provided with transverse black bands.
Abdomen: Sub-oval, longer than wide, anterior end wider than posterior end, clothed with pubescence and hairs, overlapping on the cephalothorax. Dorsum of abdomen provided with a conspicuous mid-longitudinal chalk white bar having four pairs of lateral projections. Four pairs of sigilla present on the dorsum, arranged mid-longitudinally. Ventral side light brownish, mid-ventrally having a deep brown broad patch in between epigastric furrow and the spinnerets, lateral sides of this patch guarded by chalk white patches.

Field Ecology: Very common spider generally found below fresh leaves during the day and sits in an inverted position in the orb web during evenings. Generally, it builds fresh web in evenings indicates that this species is more active in darkness to hunt on nocturnal flying insects. The most preferred habitat for the species is grasslands and gardens with marshy habitats. It is one of the predominant spiders in the homestead areas.

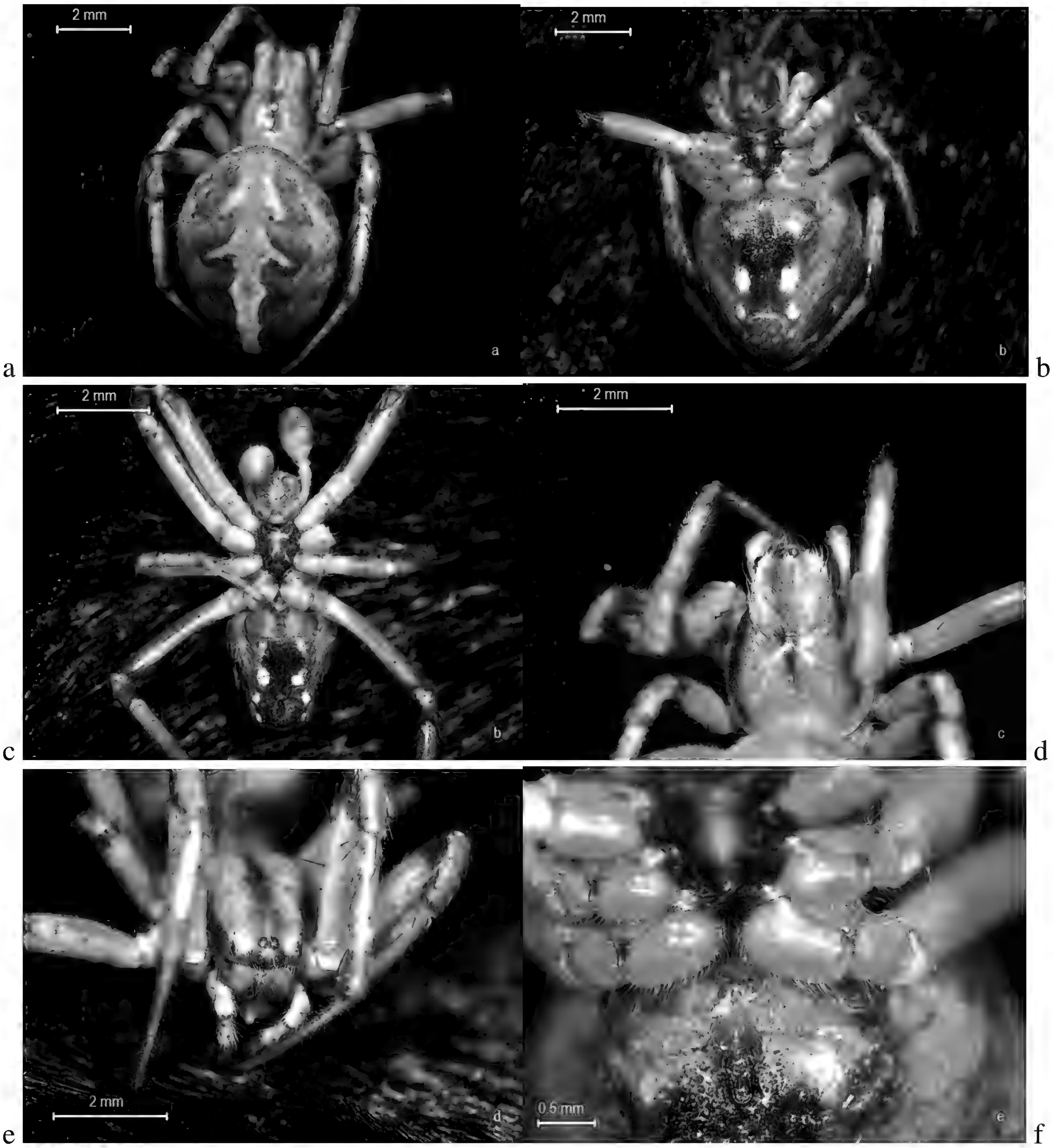

Fig. 1. *Neoscona theisi* (Walckenaer, 1841) a-b, d-f. female. a. dorsal view. b. ventral view. c. subadult male, ventral view. d. cephalothorax, dorsal view. e. eyes, frontal view. f. abdomen, ventral view showing epigyne.

Distribution: India: Gujarat, Madhya Pradesh, Maharashtra, Orissa, and West Bengal; Mediterranean to South-East Asia and Australia (Tikader, 1982; Biswas & Biswas, 1992; Barrion & Litsinger, 1995; Gajbe, 2004; World Spider Catalogue, 2023).

DNA Barcode studies: The mt DNA barcodes generated in our study were matching with sequences of *Neoscona theisi* in the NCBI Blast searches (Appendix 1). To check the monophyly of our generated *N. theisi* sequence and those available in the NCBI database, a preliminary mt COI phylogenetic tree was built which confirmed the monophyly of *N. theisi.* On the tree, *N. theisi* has representation from nine countries other than ours namely, Australia, China, French Polynesia, Germany, Japan, Oman, Pakistan, South Korea, and Spain (Fig. 2). Although Gaikwad *et al.* (2017) have published an

article on spiders from the Western Ghats, India, the same is not updated in the NCBI and as per GenBank they are unpublished. Most of the sequences of *N. theisi* in the GenBank are from different regions of Pakistan according to the studies of Ashfaq *et al.* (2019) generating a comprehensive DNA barcode library for *N. theisi.* Overall genetic distance ranged from 0.6 to 2.5% showing the genetic heterogeneity among the populations of *N. theisi*.

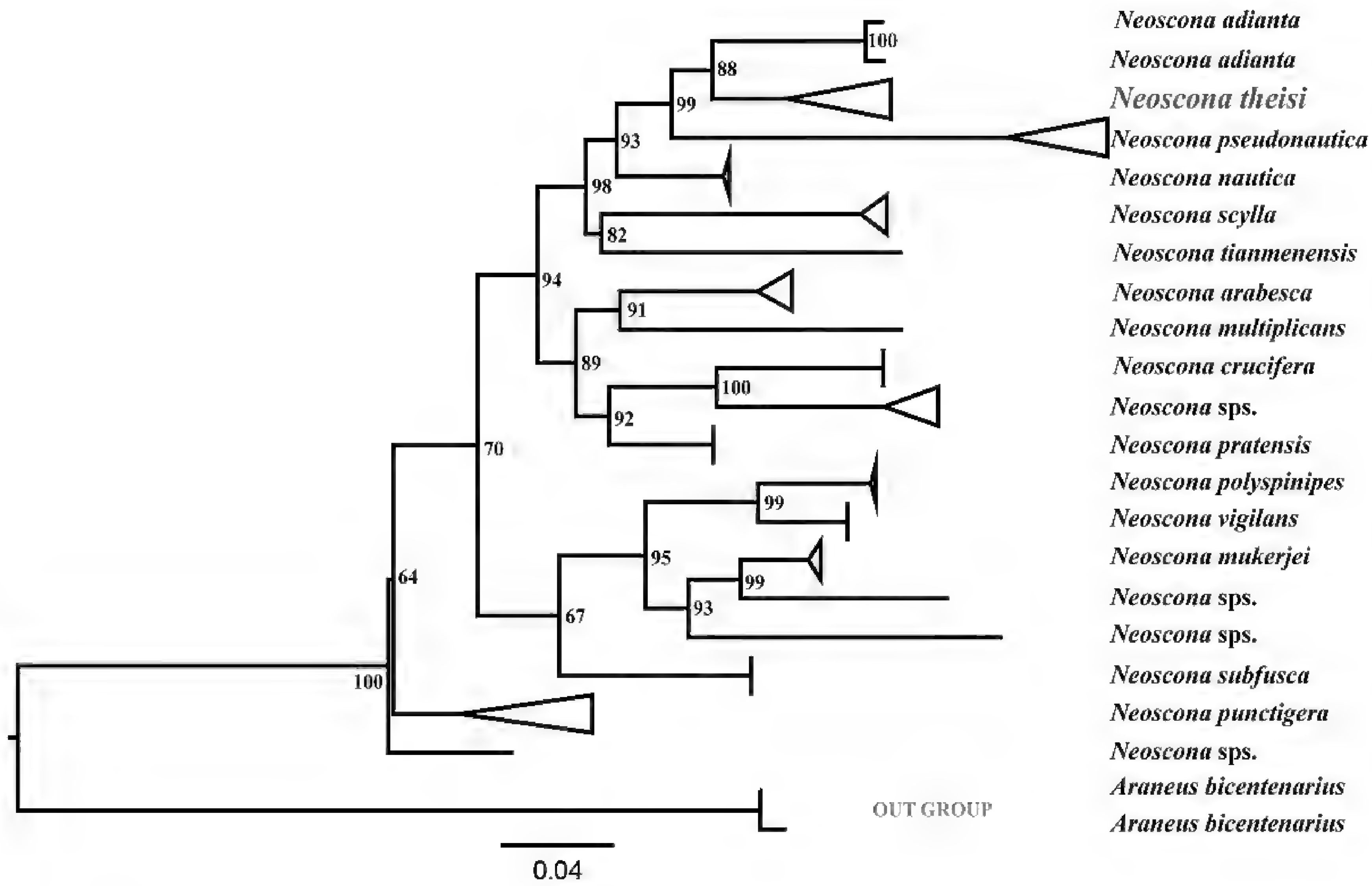

Fig. 2. Maximum Likelihood (ML) tree for the species of *Neoscona* based on 650 bp of mt COI DNA.

Discussion

In India, the species being wide range distributed their DNA barcode studies are very limited when compared to the DNA barcode studies from Pakistan which is reliable and comprehensive (Ashfaq *et al.*, 2019). Among the reported diversity of 125 species of *Neoscona* represented globally (World Spider Catalogue, 2023) we could include 19 lineages in our analysis occurring as separate clades on the tree. The Indian diversity of the genus *Neoscona* is reported to be 29 species of which five are represented on the phylogenetic tree while for rest of the 24 species DNA barcode data doesn't exist suggesting a poor reference library for the genus *Neoscona* from India. More studies for *Neoscona* from India are warranted inclusive of genetic data for building comprehensive reference library from the country. The authentic DNA barcode library from India will reinforce thorough documentation of species from diverse geographic ranges cementing the gap in Wallacean and Darwinian shortfalls of biodiversity documentation. The present study is expected to have utility not only for species identification in the future but also in other applied aspects where taxonomy remains fundamental.

Table 1. Checklist of species under genus *Neoscona* Simon, 1864 known from India.

No.	Species name	Type locality information
1	*Neoscona achine* (Simon, 1906)	Deposited at M.N.H.N., Paris, Regd. No. 21732 B 2551
2	*Neoscona bengalensis* Tikader & Bal, 1981	Jadavpur, West Bengal, India
3	*Neoscona bihumpi* Patel, 1988	Gadhada, 72 Kms south west of Bhavnagar, Gujrat, India
4	*Neoscona biswasi* Bhandari & Gajbe, 2001	Vijaynagar, Jabalpur, Madhya Pradesh, India
5	*Neoscona bomdilaensis* B. Biswas & K. Biswas, 2006	Bomdila Circuit House, Dist. Tawang, Alt. 8.400' ft., Arunachal Pradesh, India
6	*Neoscona chrysanthusi* Tikader & Bal, 1981	Mangan, near Singhik, Bhutan, India
7	*Neoscona dhruvai* Patel & Nigam, 1994	Akbarpur, Dist. Kanpur, Uttar Pradesh, India
8	*Neoscona dhumani* Patel & Reddy, 1993	Bhimunipatnam, Dist. Vishakhapatnam, Andhra Pradesh
9	*Neoscona dyali* Gajbe, 2004	Khandari, Jabalpur, Madhya Pradesh, India
10	*Neoscona elliptica* Tikader & Bal, 1981	---
11	*Neoscona enucleata* (Karsch, 1879)	Rietner
12	*Neoscona molemensis* Tikader & Bal, 1981	Molem, Goa
13	*Neoscona mukerjei* Tikader, 1980	Pune, Mahrashtra
14	*Neoscona murthyi* Patel & Reddy, 1990	Bhavnagar University Campus, Dist. Bhavnagar, Gujrat, India
15	*Neoscona nautica* (L. Koch, 1875)	African coast of the Red Sea near Suakin
16	*Neoscona odites* (Simon, 1906)	deposited at M.N.H.N., Paris, Regd. No. 6499 B 2551
17	*Neoscona parambikulamensis* Patel, 2003	Karianshola, Parambikulam Wildlife Sanctuary, Dist. Palakkad, Kerala, India
18	*Neoscona pavida* (Simon, 1906)	deposited at M.N.H.N., Paris, Regd. No. 11562 B 2551
19	*Neoscona platnicki* Gajbe & Gajbe, 2001	Sanjivaninagar, Jabalpur, Madhya Pradesh, India
20	*Neoscona punctigera* (Doleschall, 1857)	Amboina (now Ambon, Indonesia)
21	*Neoscona raydakensis* Saha, Biswas, Majumder & Raychaudhuri, 1995	South Raydak, Buxa Tiger Reserve, Jalpaiguri, West Bengal, India
22	*Neoscona sanghi* Gajbe, 2004	MR-4 Road, Jabalpur, Madhya Pradesh, India
23	*Neoscona sanjivani* Gajbe, 2004	Sanjivani Nagar, Jabalpur, Madhya Pradesh, India
24	*Neoscona shillongensis* Tikader & Bal, 1981	Shillong, Meghalaya, India
25	*Neoscona sinhagadensis* (Tikader, 1975)	Sinhagad Fort, Pune, Maharashtra
26	*Neoscona theisi* (Walckenaer, 1841)	Guam, Mariana Island, South New Guinea

27	*Neoscona triangula* (Keyserling, 1864)	---
28	*Neoscona ujavalai* Reddy & Patel, 1992	Tadikalapudi, Dist. West Godavari, Andhra Pradesh, India
29	*Neoscona usbonga* Barrion & Litsinger, 1995	Hinaplanan, Claveria, Misamis Oriental Province, Mindanao Island, Philippines
30	*Neoscona vigilans* (Blackwall, 1865)	Shire River Basin- Zambesi, East of Central Africa
31	*Neoscona xishanensis* Yin, Wang, Xie & Peng, 1990	---
32	*Neoscona yptinika* Barrion & Litsinger, 1995	Magsaysay, Siniloan, Luzon Island, Laguna Province, Philippines

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Appendix 1. Sequences details of ~650 bp of mt COI gene used for ML phylogenetic analysis.

No.	Gen Bank Acc. No.	Locality	Species name	Reference
1	MK153833.1	Pakistan: Punjab, Sargodha, Mateela Kotmomin Sargodha, Citrus field	*Neoscona theisi*	Ashfaq *et al.* (2019)
2	MK154964.1	Pakistan: Punjab, Sargodha, Chak No. 33 S.B. Sargodha, Citrus field	*Neoscona theisi*	Ashfaq *et al.* (2019)
3	MK154497.1	Pakistan: Punjab, NIBGE, Faisalabad	*Neoscona theisi*	Ashfaq *et al.* (2019)
4	JN306190.1	Pakistan	*Neoscona theisi*	Unpublished
5	MK154760.1	Pakistan: Punjab, JHELUM, P.D KHAN	*Neoscona theisi*	Ashfaq *et al.* (2019)
6	JN306330.1	Pakistan	*Neoscona theisi*	Unpublished
7	MK154878.1	Pakistan: Punjab, Bahawalpur, Multan Bypass	*Neoscona theisi*	Ashfaq *et al.* (2019)
8	MK153885.1	Pakistan: Punjab, NIBGE, Faisalabad	*Neoscona theisi*	Ashfaq *et al.* (2019)
9	JN306030.1	Pakistan	*Neoscona theisi*	Unpublished
10	MK154982.1	Pakistan: Punjab, Bahawalpur, Lodhara	*Neoscona theisi*	Ashfaq *et al.* (2019)
11	MK154368.1	Pakistan: Punjab, Sadiqabad, Rasheedabad	*Neoscona theisi*	Ashfaq *et al.* (2019)
12	JN306039.1	Pakistan	*Neoscona theisi*	Unpublished
13	MK154992.1	Pakistan: Punjab, Chichawatni, Chichawatni Forest	*Neoscona theisi*	Ashfaq *et al.* (2019)
14	MK154338.1	Pakistan: Punjab, Faisalabad, PARS	*Neoscona theisi*	Ashfaq *et al.* (2019)
15	HQ991594.1	Pakistan	*Neoscona theisi*	Unpublished
16	MK154994.1	Pakistan: Punjab, Bahawalpur, Bakkar Pur	*Neoscona theisi*	Ashfaq *et al.* (2019)
17	MK154040.1	Pakistan: Punjab, Sargodha, Chak No. 90 S.B. Sargodha, Citrus field	*Neoscona theisi*	Ashfaq *et al.* (2019)

18	HQ991602.1	Pakistan	*Neoscona theisi*	Unpublished
19	MK154897.1	Pakistan: Punjab, Multan, Sujaabad	*Neoscona theisi*	Ashfaq *et al.* (2019)
20	JF884433.1	Pakistan	*Neoscona theisi*	Unpublished
21	MK154599.1	Pakistan: Punjab, Bahawalpur, Multan Bypass	*Neoscona theisi*	Ashfaq *et al.* (2019)
22	MK154931.1	Pakistan: Punjab, Chichawatni, Chichawatni Forest	*Neoscona theisi*	Ashfaq *et al.* (2019)
23	MK153867.1	Pakistan: Punjab, Sargodha, bhagtanwala, Citric field	*Neoscona theisi*	Ashfaq *et al.* (2019)
24	MK154418.1	Pakistan: Punjab, Bahawalpur, Channan Walla	*Neoscona theisi*	Ashfaq *et al.* (2019)
25	MK154526.1	Pakistan: Punjab, Sargodha, Chak No. 90 S.B. Sargodha, Citrus field	*Neoscona theisi*	Ashfaq *et al.* (2019)
26	JN306243.1	Pakistan	*Neoscona theisi*	Unpublished
27	MK154495.1	Pakistan: Punjab, Sadiqabad, Rasheedabad	*Neoscona theisi*	Ashfaq *et al.* (2019)
28	MK153879.1	Pakistan: Punjab, Bahawalpur, Lodhara	*Neoscona theisi*	Ashfaq *et al.* (2019)
29	MK154044.1	Pakistan: Punjab, Sadiqabad, Beggar Garhi	*Neoscona theisi*	Ashfaq *et al.* (2019)
30	HQ991605.1	Pakistan	*Neoscona theisi*	Unpublished
31	JN306149.1	Pakistan	*Neoscona theisi*	Unpublished
32	MK154674.1	Pakistan: Punjab, Lahore, Punjab University, Maize Field	*Neoscona theisi*	Ashfaq *et al.* (2019)
33	MK154819.1	Pakistan: Punjab, Multan, Khokhara Basti	*Neoscona theisi*	Ashfaq *et al.* (2019)
34	MK154453.1	Pakistan: Punjab, Lahore, Punjab University, Rice field	*Neoscona theisi*	Ashfaq *et al.* (2019)
35	MK154473.1	Pakistan: Punjab, Bahawalpur, Bakkar Pur	*Neoscona theisi*	Ashfaq *et al.* (2019)
36	MK153917.1	Pakistan: Punjab, Multan, Naag Shah	*Neoscona theisi*	Ashfaq *et al.* (2019)
37	MK154751.1	Pakistan: Punjab, JHELUM, P.D KHAN	*Neoscona theisi*	Ashfaq *et al.* (2019)
38	MK154656.1	Pakistan: Punjab, Jhang, Shorkot City, Basti Haider Abad, Trifolium Field	*Neoscona theisi*	Ashfaq *et al.* (2019)
39	MK153983.1	Pakistan: Punjab, JHELUM, P.D KHAN	*Neoscona theisi*	Ashfaq *et al.* (2019)
40	JN306120.1	Pakistan	*Neoscona theisi*	Unpublished
41	JF884424.1	Pakistan	*Neoscona theisi*	Unpublished
42	KT383679.1	India: Maharashtra, Pune	*Neoscona theisi*	Gaikwad *et al.* (2017)
43	KT383768.1	India: Maharashtra, Pune	*Neoscona theisi*	Gaikwad *et al.* 2017

44	MK154156.1	Pakistan: Punjab, Chichawatni, Chichawatni Forest	*Neoscona theisi*	Ashfaq *et al.* (2019)
45	KX054033.1	French Polynesia: huahine island, mount pohue	*Neoscona theisi*	Ramage *et al.* (2017)
46	KX054031.1	French Polynesia: raiatea island, pension croix du sud faaroa bay gardens	*Neoscona theisi*	Ramage *et al.* (2017)
47	KX054028.1	French Polynesia: raiatea island, Marae taputapuatea	*Neoscona theisi*	Ramage *et al.* (2017)
48	KX054029.1	French Polynesia: huahine island, motu maeva	*Neoscona theisi*	Ramage *et al.* (2017)
49	KX054030.1	French Polynesia: raiatea island, marae taputapuatea	*Neoscona theisi*	Ramage *et al.* (2017)
50	KX054025.1	French Polynesia: tahiti island, Mount mauru dike	*Neoscona theisi*	Ramage *et al.* (2017)
51	KX054027.1	French Polynesia: moorea island, Vaiare paopao track	*Neoscona theisi*	Ramage *et al.* (2017)
52	KX054032.1	French Polynesia: huahine island, faie river area	*Neoscona theisi*	Ramage *et al.* (2017)
53	HQ583923.1	Australia	*Neoscona. theisi*	Unpublished
54	MK154469.1	Pakistan: Punjab, Bahawalpur, Lodharan Road	*Neoscona theisi*	Ashfaq *et al.* (2019)
55	HQ991597.1	Pakistan	*Neoscona theisi*	Unpublished
56	MK154360.1	Pakistan: Punjab, Jhelum, Tober valley	*Neoscona theisi*	Ashfaq *et al.* (2019)
57	MK154235.1	Pakistan: Punjab, NIBGE, Faisalabad	*Neoscona theisi*	Ashfaq *et al.* (2019)
58	MK154763.1	Pakistan: Punjab, Sadiqabad, Rasheedabad	*Neoscona theisi*	Ashfaq *et al.* (2019)
59	JN306257.1	Pakistan	*Neoscona theisi*	Unpublished
60	MK153846.1	Pakistan: Punjab, Multan, Khokhara Basti	*Neoscona theisi*	Ashfaq *et al.* (2019)
61	MK154213.1	Pakistan: Punjab, Jhang, Shorkot City, Basti Haider Abad, Trifolium Field	*Neoscona theisi*	Ashfaq *et al.* (2019)
62	MK154826.1	Pakistan: Punjab, Sadiqabad, Rasheedabad	*Neoscona theisi*	Ashfaq *et al.* (2019)
63	MK154417.1	Pakistan: Punjab, Sargodha, Chak No. 34 S.B. Sargodha, Citrus field	*Neoscona theisi*	Ashfaq *et al.* (2019)
64	JN306073.1	Pakistan	*Neoscona theisi*	Unpublished
65	MK154271.1	Pakistan: Punjab, Jhelum, P.D Khan	*Neoscona theisi*	Ashfaq *et al.* (2019)
66	MK154791.1	Pakistan: Punjab, Bahawalpur, Channan Walla	*Neoscona theisi*	Ashfaq *et al.* (2019)
67	MK154758.1	Pakistan: Punjab, Multan, Sujaabad	*Neoscona theisi*	Ashfaq *et al.* (2019)
68	MK153933.1	Pakistan: Punjab, Faisalabad,	*Neoscona theisi*	Ashfaq *et al.*

		PARS		(2019)
69	MK154757.1	Pakistan: Punjab, Multan, Khokhara Basti	*Neoscona theisi*	Ashfaq *et al.* (2019)
70	MK154681.1	Pakistan: Punjab, Bahawalpur, Channan Walla	*Neoscona theisi*	Ashfaq *et al.* (2019)
71	MK154530.1	Pakistan: Punjab, Multan, Naag Shah	*Neoscona theisi*	Ashfaq *et al.* (2019)
72	MK155020.1	Pakistan: Punjab, Bahawalpur, Channan Walla	*Neoscona theisi*	Ashfaq *et al.* (2019)
73	MK154962.1	Pakistan: Punjab, Bahawalpur, Multan Bypass	*Neoscona theisi*	Ashfaq *et al.* (2019)
74	MK154021.1	Pakistan: Punjab, Bahawalpur, Bakkar Pur	*Neoscona theisi*	Ashfaq *et al.* (2019)
75	JN306178.1	Pakistan	*Neoscona theisi*	Unpublished
76	JN306042.1	Pakistan	*Neoscona theisi*	Unpublished
77	MK154542.1	Pakistan: Punjab, Multan, Sujaabad	*Neoscona theisi*	Ashfaq *et al.* (2019)
78	MK154906.1	Pakistan: Punjab, Jhelum, Khewra	*Neoscona theisi*	Ashfaq *et al.* (2019)
79	JF884361.1	Pakistan	*Neoscona theisi*	Unpublished
80	MK154361.1	Pakistan: Punjab, Multan, Sujaabad	*Neoscona theisi*	Ashfaq *et al.* (2019)
81	MK154459.1	Pakistan: Punjab, Sadiqabad, Sadiqabad	*Neoscona theisi*	Ashfaq *et al.* (2019)
82	JF884432.1	Pakistan	*Neoscona theisi*	Unpublished
83	MK154362.1	Pakistan: Punjab, Soan Valley, jhalar, vegetation	*Neoscona theisi*	Ashfaq *et al.* (2019)
84	MK153980.1	Pakistan: Punjab, Jhelum, Khewra	*Neoscona theisi*	Ashfaq *et al.* (2019)
85	MK950521.1	Oman	*Neoscona theisi*	Unpublished
86	MK950520.1	Oman	*Neoscona theisi*	Unpublished
87	JN306320.1	Pakistan	*Neoscona theisi*	Unpublished
88	MK154346.1	Pakistan: Punjab, Sargodha, Chak No. 33 S.B. Sargodha, Citrus field	*Neoscona theisi*	Ashfaq *et al.* (2019)
89	JN306199.1	Pakistan	*Neoscona theisi*	Unpublished
90	MK154922.1	Pakistan: Punjab, Multan, Naag Shah	*Neoscona theisi*	Ashfaq *et al.* (2019)
91	MK154801.1	Pakistan: Punjab, Multan, Khokhara Basti	*Neoscona theisi*	Ashfaq *et al.* (2019)
92	MK154377.1	Pakistan: Punjab, Sargodha, Mateela Kotmomin Sargodha, Citrus field	*Neoscona theisi*	Ashfaq *et al.* (2019)
93	MK153918.1	Pakistan: Punjab, Jhelum, lilah road	*Neoscona theisi*	Ashfaq *et al.* (2019)
94	MK154954.1	Pakistan: Punjab, Jhelum, Khewra	*Neoscona theisi*	Ashfaq *et al.* (2019)
95	MK153892.1	Pakistan: Punjab, Multan, Sujaabad	*Neoscona theisi*	Ashfaq *et al.* (2019)

96	MK153849.1	Pakistan: Punjab, Bahawalpur, Multan Bypass	*Neoscona theisi*	Ashfaq *et al.* (2019)
97	MK154857.1	Pakistan: Punjab, Rajana, Rajana Forest	*Neoscona theisi*	Ashfaq *et al.* (2019)
98	MK154094.1	Pakistan: Punjab, Multan, Kasba Marral	*Neoscona theisi*	Ashfaq *et al.* (2019)
99	MK153876.1	Pakistan: Punjab, Khushab, dhap shareef, vegetation	*Neoscona theisi*	Ashfaq *et al.* (2019)
100	MK153872.1	Pakistan: Punjab, Bahawalpur, Lodhara	*Neoscona theisi*	Ashfaq *et al.* (2019)
101	MK154389.1	Pakistan: Punjab, Multan, Sujaabad	*Neoscona theisi*	Ashfaq *et al.* (2019)
102	MK154026.1	Pakistan: Punjab, Sadiqabad, Rasheedabad	*Neoscona theisi*	Ashfaq *et al.* (2019)
103	MK154216.1	Pakistan: Punjab, Bahawalpur, Channan Walla	*Neoscona theisi*	Ashfaq *et al.* (2019)
104	MK154315.1	Pakistan: Punjab, Faisalabad, PARS	*Neoscona theisi*	Ashfaq *et al.* (2019)
105	MK154319.1	Pakistan: Punjab, Bahawalpur, Bakkar Pur	*Neoscona theisi*	Ashfaq *et al.* (2019)
106	JN306084.1	Pakistan	*Neoscona theisi*	Unpublished
107	MK153884.1	Pakistan: Punjab, Sargodha, Chak No. 37 S.B. Sargodha, Citrus field	*Neoscona theisi*	Ashfaq *et al.* (2019)
108	MK154212.1	Pakistan: Punjab, Lahore, Punjab University, Maize Field	*Neoscona theisi*	Ashfaq *et al.* (2019)
109	JN306299.1	Pakistan	*Neoscona theisi*	Unpublished
110	MK153935.1	Pakistan: Punjab, Multan, Sujaabad	*Neoscona theisi*	Ashfaq *et al.* (2019)
111	MK153971.1	Pakistan: Punjab, Sadiqabad, Sadiqabad	*Neoscona theisi*	Ashfaq *et al.* (2019)
112	MK154229.1	Pakistan: Punjab, NIBGE, Faisalabad	*Neoscona theisi*	Ashfaq *et al.* (2019)
113	MK154504.1	Pakistan: Punjab, Jhelum, lilah road	*Neoscona theisi*	Ashfaq *et al.* (2019)
114	JN306093.1	Pakistan	*Neoscona theisi*	Unpublished
115	MK154468.1	Pakistan: Punjab, Bahawalpur, Bakkar Pur	*Neoscona theisi*	Ashfaq *et al.* (2019)
116	MK153950.1	Pakistan: Punjab, Bahawalpur, Multan Bypass	*Neoscona theisi*	Ashfaq *et al.* (2019)
117	MK154703.1	Pakistan: Punjab, Sargodha, bhagtanwala, Citrus field	*Neoscona theisi*	Ashfaq *et al.* (2019)
118	JF884420.1	Pakistan	*Neoscona theisi*	Unpublished
119	MK153925.1	Pakistan: Punjab, Sargodha, Chak No. 87 N.B. Sargodha, Citrus field	*Neoscona theisi*	Ashfaq *et al.* (2019)
120	MK154449.1	Pakistan: Punjab, Jhelum, Tober valley	*Neoscona theisi*	Ashfaq *et al.* (2019)

121	MK153832.1	Pakistan: Punjab, Sargodha, bhagtanwala, Citrus field	*Neoscona theisi*	Ashfaq *et al.* (2019)
122	MK154059.1	Pakistan: Punjab, Multan, Sujaabad	*Neoscona theisi*	Ashfaq *et al.* (2019)
123	MK154363.1	Pakistan: Punjab, Multan, Bolail Wala	*Neoscona theisi*	Ashfaq *et al.* (2019)
124	JN306319.1	Pakistan	*Neoscona theisi*	Unpublished
125	MK153996.1	Pakistan: Punjab, Jhelum, Khewra	*Neoscona theisi*	Ashfaq *et al.* (2019)
126	JF884306.1	Pakistan	*Neoscona theisi*	Unpublished
127	JN306297.1	Pakistan	*Neoscona theisi*	Unpublished
128	JN306141.1	Pakistan	*Neoscona theisi*	Unpublished
129	MK154055.1	Pakistan: Punjab, Lahore, Punjab University, Maize field	*Neoscona theisi*	Ashfaq *et al.* (2019)
130	MK153857.1	Pakistan: Punjab, Rajana, Rajana Forest	*Neoscona theisi*	Ashfaq *et al.* (2019)
131	JN306278.1	Pakistan	*Neoscona theisi*	Unpublished
132	MK154894.1	Pakistan: Punjab, Multan, Sujaabad	*Neoscona theisi*	Ashfaq *et al.* (2019)
133	MK154256.1	Pakistan: Punjab, Multan, Multan	*Neoscona theisi*	Ashfaq *et al.* (2019)
134	MK154900.1	Pakistan: Punjab, Rajanpur, Rajanpur	*Neoscona theisi*	Ashfaq *et al.* (2019)
135	MK154871.1	Pakistan: Punjab, JHELUM, P.D KHAN	*Neoscona theisi*	Ashfaq *et al.* (2019)
136	MK154916.1	Pakistan: Punjab, Multan, Naag Shah	*Neoscona theisi*	Ashfaq *et al.* (2019)
137	MK154620.1	Pakistan: Punjab, Bahawalpur, Bakkar Pur	*Neoscona theisi*	Ashfaq *et al.* (2019)
138	MK154399.1	Pakistan: Punjab, NIBGE, Faisalabad	*Neoscona theisi*	Ashfaq *et al.* (2019)
139	MK154386.1	Pakistan: Punjab, Sargodha, Mateela Kotmomin Sargodha, Citrus field	*Neoscona theisi*	Ashfaq *et al.* (2019)
140	JF884429.1	Pakistan	*Neoscona theisi*	Unpublished
141	OR116096.1	India: ZSI, WRC, Akurdi Pune.	*Neoscona_theisi*	This study
142	OR116097.1	India: ZSI, WRC, Akurdi Pune.	*Neoscona_theisi*	This study
143	MK154332.1	Pakistan: Punjab, Multan, Sujaabad	*Neoscona theisi*	Ashfaq *et al.* (2019)
144	MK154926.1	Pakistan: Punjab, Lahore, Punjab University, Rice field	*Neoscona theisi*	Ashfaq *et al.* (2019)
145	MK154634.1	Pakistan: Punjab, Rajana, Rajana Forest	*Neoscona theisi*	Ashfaq *et al.* (2019)
146	MK559320.1	India	*Neoscona theisi*	Unpublished
147	MK154465.1	Pakistan: Punjab, Multan, Sujaabad	*Neoscona theisi*	Ashfaq *et al.* (2019)

148	JN306334.1	Pakistan	*Neoscona theisi*	Unpublished
149	MK154297.1	Pakistan: Punjab, Jhelum, Tober valley	*Neoscona theisi*	Ashfaq *et al.* (2019)
150	JN306161.1	Pakistan	*Neoscona theisi*	Unpublished
151	HQ991607.1	Pakistan	*Neoscona theisi*	Unpublished
152	JN306119.1	Pakistan	*Neoscona theisi*	Unpublished
153	MK154146.1	Pakistan: Punjab, Multan, Sujaabad	*Neoscona theisi*	Ashfaq *et al.* (2019)
154	MK154793.1	Pakistan: Punjab, Rajana, Rajana Forest	*Neoscona theisi*	Ashfaq *et al.* (2019)
155	MK154217.1	Pakistan: Punjab, Jhang, Shorkot City, Basti Haider Abad, Trifolium Field	*Neoscona theisi*	Ashfaq *et al.* (2019)
156	MK154769.1	Pakistan: Punjab, Bahawalpur, Channan Walla	*Neoscona theisi*	Ashfaq *et al.* (2019)
157	MK154707.1	Pakistan: Punjab, Bahawalpur, Lodhara	*Neoscona theisi*	Ashfaq *et al.* (2019)
158	MK154350.1	Pakistan: Punjab, Multan, Basti Jalalabad	*Neoscona theisi*	Ashfaq *et al.* (2019)
159	MK154429.1	Pakistan: Punjab, Jhang, Shorkot City, Basti Haider Abad, Trifolium Field	*Neoscona theisi*	Ashfaq *et al.* (2019)
160	MK154025.1	Pakistan: Punjab, NIBGE, Faisalabad	*Neoscona theisi*	Ashfaq *et al.* (2019)
161	MK154850.1	Pakistan: Punjab, Sargodha, Sargodha	*Neoscona theisi*	Ashfaq *et al.* (2019)
162	MK154849.1	Pakistan: Punjab, Jhelum, Tober valley	*Neoscona theisi*	Ashfaq *et al.* (2019)
163	MK154932.1	Pakistan: Punjab, Sadiqabad, Beggar Garhi	*Neoscona theisi*	Ashfaq *et al.* (2019)
164	MK154385.1	Pakistan: Punjab, Sargodha, Chak No. 34 S.B. Sargodha, Citrus field	*Neoscona theisi*	Ashfaq *et al.* (2019)
165	MK154327.1	Pakistan: Punjab, Bahawalpur, Bakkar Pur	*Neoscona theisi*	Ashfaq *et al.* (2019)
166	JF884332.1	Pakistan	*Neoscona theisi*	Unpublished
167	HQ991599.1	Pakistan	*Neoscona theisi*	Unpublished
168	JN306322.1	Pakistan	*Neoscona theisi*	Unpublished
169	MK154165.1	Pakistan: Punjab, JHELUM, P.D KHAN	*Neoscona theisi*	Ashfaq *et al.* (2019)
170	MK153853.1	Pakistan: Punjab, Chichawatni, Chichawatni Forest	*Neoscona theisi*	Ashfaq *et al.* (2019)
171	JN306228.1	Pakistan	*Neoscona theisi*	Unpublished
172	MK154732.1	Pakistan: Punjab, Jhelum, Khewra	*Neoscona theisi*	Ashfaq *et al.* (2019)
173	MK154224.1	Pakistan: Punjab, Sargodha, Chak No. 37 S.B. Sargodha, Citrus field	*Neoscona theisi*	Ashfaq *et al.* (2019)

174	JN306215.1	Pakistan	*Neoscona theisi*	Unpublished
175	AB969823.1	Japan: Okinawa, Onna	*Neoscona theisi*	Unpublished
176	JN817155.1	South Korea	*Neoscona theisi*	Unpublished
177	KY467220.1	China	*Neoscona theisi*	Wang *et al.* (2017)
178	KY467221.1	China	*Neoscona theisi*	Wang *et al.* (2017)
179	KP100667.1	Guo Xiang Qiao Zhong Lu, Yu Yao Shi, Ning Bo Shi, Zhe Jing Sheng, China	*Neoscona theisi*	Unpublished
180	KY467219.1	China	*Neoscona theisi*	Wang *et al.* (2017)
181	MK154529.1	Pakistan: Punjab, Bahawalpur, Chandi Garh	*Neoscona theisi*	Ashfaq *et al.* (2019)
182	KX054026.1	French Polynesia: moorea island, Opunohu three coconut ridge	*Neoscona theisi*	Ramage *et al.* (2017)
183	MT607826.1	Spain: Castilla-La Mancha, Ciudad Real, Alcoba, La Quesera	*Neoscona adianta*	Macías-Hernandez *et al.* (2020)
184	KY270394.1	Germany: Saxony, Dresdener Heller, Umgebung Dresdener Heller	*Neoscona adianta*	Astrin *et al.* (2016)
185	MN202169.1	China	*Neoscona pseudonautica*	Unpublished
186	JN817148.1	South Korea	*Neoscona pseudonautica*	Unpublished
187	JN817147.1	South Korea	*Neoscona nautica*	Unpublished
188	KT383706.1	India: Maharashtra, Pune	*Neoscona nautica*	Unpublished
189	MK154412.1	Punjab, Sargodha, Chak No. 87 N.B. Sargodha, Citrus field	*Neoscona* sps.	Ashfaq *et al.* (2019)
190	MK155031.1	Pakistan: Khyber Pakhtunkhwa, Kaghan, SARS, Summer Agri Res.St	*Neoscona scylla*	Ashfaq *et al.* (2019)
191	MK154903.1	Pakistan: Khyber Pakhtunkhwa, Shogran, Shogran	*Neoscona scylla*	Ashfaq *et al.* (2019)
192	JN817154.1	South Korea	*Neoscona tianmenensis*	Unpublished
193	DQ127496.1	Canada	*Neoscona arabesca*	Unpublished
194	EU003301.1	USA	*Neoscona arabesca*	Álvarez-Padilla *et al.* (2009)
195	JN817150.1	South Korea	*Neoscona multiplicans*	Unpublished
196	FJ525327.1	USA	*Neoscona*	Agnarsson &

			crucifera	Blackledge (2009)
197	MK420138.1	Norway	*Neoscona crucifera*	Scharff *et al.* (2020)
198	KC662168.1	New York, Cold Spring Harbor, Cold Spring Harbor Laboratory Bay	*Neoscona* sps.	Lu *et al.* (2013)
199	MF811292.1	Canada: Ontario, Point Pelee National Park, Woodland Trail	*Neoscona* sps.	Unpublished
200	MF812071.1	Canada: Ontario, Point Pelee National Park, Woodland Trail	*Neoscona* sps.	Unpublished
201	MF813442.1	Canada: Ontario, Point Pelee National Park, Woodland Trail	*Neoscona* sps.	Unpublished
202	MF814829.1	Canada: Ontario, Point Pelee National Park, Woodland Trail	*Neoscona* sps.	Unpublished
203	KM840069.1	Canada: Saskatchewan, Grasslands NP, Grasslands Nat. Park Butte trail	*Neoscona pratensis*	Blagoev *et al.* (2016)
204	KM837328.1	Canada: Saskatchewan, Grasslands NP, Grasslands Nat. Park Butte trail	*Neoscona pratensis*	Blagoev *et al.* (2016)
205	KP862583.1	China	*Cyclosa argenteoalba*	Xu *et al.* (2019)
206	MF467584.1	China	*Neoscona punctigera*	Unpublished
207	JN817151.1	South Korea	*Neoscona punctigera*	Unpublished
208	MK154050.1	Pakistan: Punjab, Sargodha, shahpur, Citrus field	*Neoscona* sps.	Ashfaq *et al.* (2019)
209	JN306160.1	Pakistan	*Neoscona subfusca*	Unpublished
210	MK950519.1	Oman	*Neoscona subfusca*	Unpublished
211	MK155010.1	Pakistan: Punjab, Jhelum, Khewra	*Neoscona polyspinipes*	Ashfaq *et al.* (2019)
212	MK154986.1	Pakistan: Punjab, Jhelum, Khewra	*Neoscona polyspinipes*	Ashfaq *et al.* (2019)
213	HQ991609.1	Pakistan	*Neoscona vigilans*	Unpublished
214	MK155003.1	Pakistan: Punjab, Jhelum, Khewra	*Neoscona vigilans*	Ashfaq *et al.* (2019)
215	KT383761.1	India: Maharashtra, Pune	*Neoscona mukerjei*	Unpublished
216	KT383737.1	India: Maharashtra, Pune	*Neoscona mukerjei*	Unpublished

217	KR526561.1	Slovenia	*Neoscona* sps	Gregorič *et al.* (2015)
218	KT383727.1	India: Maharashtra, Pune	*Neoscona* sps.	Unpublished
219	MG508687.1	Canada: Nova Scotia, Kejimkujik, Kejimkujik	*Araneus bicentenarius*	DeWaard *et al.* (2019)
220	MK420061.1	NA	*Araneus bicentenarius*	Scharff *et al.* (2020)